

Amphiphilic Copolymer-Lipid Chimeric Nanosystems as DNA Vectors

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Website (<https://www.chem.uni-potsdam.de/groups/boeker/>)

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Lehrstuhl für Polymermaterialien und Polymertechnologie, University of Potsdam, 14476 Potsdam-Golm, Germany

Interests: self-assembly of block copolymers and nanoparticles; multi-functional patchy particles; Pickering-Emulsions; protein-polymer conjugates; integration of biological functions into polymeric materials

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Prof. Dr. Rafael Antonio Balart Gimeno (<https://sciprofiles.com/profile/335440>)

Website (<http://www.upv.es/ficha-personal/rbalart>)

Section Associate Editor

Technological Institute of Materials (ITM), Universitat Politècnica de València (UPV), 03801 Alcoy, Spain

Interests: aliphatic polyesters; blends; compatibilization; advanced characterization; functional additives; unsaturated polyester resins; composites

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Prof. Dr. Ilker S. Bayer (<https://sciprofiles.com/profile/223098>)

Website (<https://www.iit.it/people/ilker-bayer>)

Section Associate Editor

Istituto Italiano di Tecnologia, Genoa, Italy

Interests: bioinspired surfaces; wetting; biopolymers; polymer nanocomposites

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Nadka Tz. Dintcheva (<https://sciprofiles.com/profile/390552>)

Website (https://www.unipa.it/persone/docenti/d/nadka_dintcheva/)

Section Associate Editor

Department of Engineering, University of Palermo, 90128 Palermo, Italy

Interests: structure/processing/properties relationships in polymers; biopolymers; micro- and nano- composites; polymers and biopolymers degradation and stabilization

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Mariaenrica Frigione (<https://sciprofiles.com/profile/33550>)

Website (<https://www.unisalento.it/scheda-utente/-/people/mariaenrica.frigione/biografia>)

Section Associate Editor

Innovation Engineering Department, University of Salento, Prov.le Lecce-Monteroni, 73100 Lecce, Italy

Interests: cold-cured adhesives and matrices for FRP employed in constructions; polymeric nanostructured adhesives and coatings; hydrophobic coatings for stone conservation and wood protection; durability of polymers, adhesives and coatings; eco-efficient materials for construction and cultural heritage

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Prof. Dr. Peter Griffiths (<https://sciprofiles.com/profile/556701>)

Website (<https://www.gre.ac.uk/people/rep/faculty-of-engineering-and-science/peter-griffiths/>)

Section Associate Editor

School of Science, Faculty of Engineering and Science, University of Greenwich, Chatham Maritime, Kent ME4 4TB, UK

Interests: formulation; polymer-surfactant mixtures; polymer-particle interactions; polymer complexation; self-assembly; pulsed-gradient spin-echo NMR; neutron scattering

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Prof. Dr. Vitaliy V. Khutoryanskiy (<https://sciprofiles.com/profile/365743>)

Website (<https://www.reading.ac.uk/pharmacy/about/staff/v-khutoryanskiy.aspx>)

Section Associate Editor

Reading School of Pharmacy, University of Reading, Reading RG6 6AD, UK

Interests: water-soluble polymers; hydrogels; polymer complexes; drug delivery; mucoadhesion; nanomaterials

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Dr. Marta Otero (<https://sciprofiles.com/profile/104751>)

Website1 (<http://www.cesam.ua.pt/index.php?tabela=pessoaldetail&menu=82&user=87>) **Website2** (<https://www.researchgate.net/profile/Marta-Otero>)

Section Associate Editor

CESAM (Centre for Environmental and Marine Studies) & Department of Environment and Planning, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal

Interests: pollution and contamination of water, soil and sediments; decontamination and purification of water: global treatment systems; sustainable treatment processes; clean and alternative technologies; biowastes management and valorization; novel materials: production, characterization and utilization; thermal analysis

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Website (<https://chem.uoi.gr/meli-dep/papageorgiou-georgios/>)

Section Associate Editor



Dr. Bernhard V. K. J. Schmidt (<https://sciprofiles.com/profile/286458>)

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Section Associate Editor

1. Max Planck Institute of Colloids and Interfaces, 14476 Potsdam, Germany

2. School of Chemistry, University of Glasgow, Glasgow G128QQ, UK

Interests: double-hydrophilic block copolymer self-assembly; polymerizations in confined spaces; polymers from renewable lignin feedstocks; carbon nitride-based soft polymer materials

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Dr. Andrea Sorrentino (<https://sciprofiles.com/profile/291266>)

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Section Associate Editor

Institute of Polymers, Composites and Biomaterials (IPCB), National Research Council of Italy (CNR), Via Previati 1/C, 23900 Lecco, Italy

Interests: process-properties relationships; morphology and properties of polymeric materials; polymer processing; injection and compression moulding; nanofunctionalized polymer materials for barrier and electrical applications; polymer (bio/photo)-degradation; bionanocomposites materials; thermomechanical properties; biodegradable materials; high performances composite materials; materials for sensing; materials for drug delivery; self-healing materials

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Dr. Naozumi Teramoto (<https://sciprofiles.com/profile/10936>)

[Website1](http://www.le.it-chiba.ac.jp/env-org/index.html) (<http://www.le.it-chiba.ac.jp/env-org/index.html>) [Website2](http://www.appchem.it-chiba.ac.jp/env-org/index.html) (<http://www.appchem.it-chiba.ac.jp/env-org/index.html>)

Section Associate Editor

Department of Life and Environmental Sciences, Faculty of Engineering, Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino, Chiba 275-0016, Japan

Interests: biomaterial; bio-based polymers; bioplastics; biodegradable polymers; biopolymers; composite materials comprising a polymer matrix

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Dr. Raquel Verdejo (<https://sciprofiles.com/profile/638214>)

[Website](http://www.nanocomp.ictp.csic.es/bio/RV.html) (<http://www.nanocomp.ictp.csic.es/bio/RV.html>)

Section Associate Editor

Instituto de Ciencia y Tecnología de Polímeros, Madrid, Spain

Interests: polymer composites and nanocomposites; polymer foams; smart polymers; dielectric elastomer actuators

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Prof. Dr. Dimitrios Bikiaris (<https://sciprofiles.com/profile/8950>)

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Section Editor-in-Chief

Laboratory of Polymer Chemistry and Technology, Department of Chemistry, Aristotle University of Thessaloniki, GR 54124 Thessaloniki, Greece

Interests: synthesis and characterization of polyesters; development of biobased polymers; biodegradable polymers; polymer composites and nanocomposites; synthesis and characterization of copolymers; polymer blends; recycling of polymers with various techniques; enzymatic hydrolysis studies; modification of natural polymers; polymer for wastewater treatment pollutant removal; polymers for tissue engineering and drug delivery applications; drug-polymer solid dispersions; drug targeting; drug nanoencapsulation and microencapsulation

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Prof. Dr. Martin Kröger*

[Website1](http://www.complexfluids.ethz.ch) (<http://www.complexfluids.ethz.ch>) [Website2](https://scholar.google.ch/citations?user=EUCO-BAAAAAJ&hl=de) (<https://scholar.google.ch/citations?user=EUCO-BAAAAAJ&hl=de>)

Section Editor-in-Chief

Polymer Physics, Department of Materials, ETH Zurich, Leopold-Ruzicka-Weg 4, CH-8093 Zurich, Switzerland

Interests: polymer physics; computational physics; applied mathematics; stochastic differential equations; coarse-graining; biophysics

* Section: Polymer Physics and Theory

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Prof. Dr. Francesco Paolo La Mantia (<https://sciprofiles.com/profile/225420>)

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Section Editor-in-Chief

Department of Engineering, University of Palermo, RU INSTM, Viale delle Scienze, 90128 Palermo, Italy

Interests: polymer processing; mechanical behaviour of polymer-based systems; rheological behaviour of polymer-based systems; green composites; biocomposites; nanocomposites; biodegradable polymers; polymer blends; degradation and recycling of polymer-based systems

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[★](https://clarivate.com/highly-cited-researchers/2022) (<https://clarivate.com/highly-cited-researchers/2022>) [Website](http://yklai.fzu.edu.cn/) (<http://yklai.fzu.edu.cn/>)

Section Editor-in-Chief

College of Chemical Engineering, Fuzhou University, Fuzhou 350116, China

Interests: TiO₂-based functional materials; surface and interface; biomimetics; water treatment; energy storage and conversion

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Prof. Dr. Miguel Ángel López Manchado (<https://sciprofiles.com/profile/452354>) *

MDPI (<http://www.nanocomp.ictp.csic.es/bio/MALM.html>)

Section Editor-in-Chief

Departamento de Nanomateriales Poliméricos y Biomateriales, Instituto de Ciencia y Tecnología de Polímeros, ICTP-CSIC, Juan de la Cierva (2000-CM) Madrid, Spain

Interests: processing and characterization of composite materials and nanocomposites; evaluation of structure-properties relationships in composite materials; study of elastomer compounds

* Section: Polymer Composites and Nanocomposites

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Prof. Dr. Giulio Malucelli (<https://sciprofiles.com/profile/150333>)

Website (https://didattica.polito.it/pls/portal30/sviluppo.scheda_pers_sw.as.show?m=002168)

Section Editor-in-Chief

Department of Applied Science and Technology, Politecnico di Torino, 10129 Turin, Italy

Interests: biomacromolecules; flame retardance; structure-property relationships; thermal degradation; polymer (nano)composites; biopolymers

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Prof. Dr. Vlasias Mavrantzas

Website1 (<https://www.chemeng.upatras.gr/en/personnel/faculty/53>) **Website2** (<https://scholar.google.com/citations?user=ToQyWQcAAAAJ&hl=en>)

Section Editor-in-Chief

1. Department of Chemical Engineering, University of Patras & FORTH-ICE/HT, GR 26504 Patras, Greece

2. Particle Technology Laboratory, Department of Mechanical and Process Engineering, ETH-Z, CH-8093 Zürich, Switzerland

Interests: polymer physics; polymer rheology; molecular simulations; statistical mechanics; nonequilibrium thermodynamics; constitutive modelling; dissipative quantum field theory

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Prof. Dr. Antonio Pizzi (<https://sciprofiles.com/profile/90476>) *

Website (<http://lrmab.univ-lorraine.fr/membres/pizzi-antonio/>)

Section Editor-in-Chief

LERMAB, Laboratoire d'Etude et de Recherche sur le Matériau Bois, Université de Lorraine, 27 rue Philippe Seguin, CS60036, 88021 Epinal, France

Interests: polycondensation; resins; adhesives; thermosetting polymers for adhesives; natural polymers for industrial use; fibrous and wood composites; polymeric wood constituents (cellulose, lignin, tannins)

* Section: Circular and Green Polymer Science

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Marcel Popa (<https://sciprofiles.com/profile/1092003>)

Website (<http://www.didactic.icpm.tuiasi.ro/cv/popamarcel/contact.html>)

Section Editor-in-Chief

Faculty of Chemical Engineering and Environment Protection, "Gheorghe Asachi" Technical University, Iasi, Romania

Interests: polysaccharide modification; bioactive polymers; biomaterials; hydrogels; interpenetrated networks; micro- and nanoparticles (spheres and capsules); hybrid and functionalized nanoparticles for drug targeting; drug delivery; polymer-drug conjugates

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Prof. Dr. Frank Wiesbrock (<https://sciprofiles.com/profile/2148447>) *

Website (<https://www.pcccl.at/en/>)

Section Editor-in-Chief

Institute for Chemistry and Technology of Materials, University of Technology Graz, NAWI Graz, 8010 Graz, Austria

Interests: functional polymers; ring-opening polymerizations; crosslinked polymers; biopolyesters; polymeranalogous modifications

* Section: Circular and Green Polymer Science

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Hyeonseok Yoon (<https://sciprofiles.com/profile/53824>) *

Website (<https://orcid.org/0000-0002-5403-1617>)

Section Editor-in-Chief

1. School of Polymer Science and Engineering, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju 61186, Korea

2. Department of Polymer Engineering, Graduate School, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju 61186, Korea

Interests: conducting polymers; nanoparticles; composites; sensors; electrochemistry

* Section: Polymer Applications

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Prof. Dr. Shin-Ichi Yusa (<https://sciprofiles.com/profile/6791>)

Website (<http://www.eng.u-hyogo.ac.jp/msc/yusa/index.html>)

Section Editor-in-Chief

Department of Materials Science and Chemistry, University of Hyogo, Shosha 2167, Himeji, Hyogo, Japan

Interests: controlled/living radical polymerization; RAFT; TERP; water-soluble polymer; self-organization; polymer micelle; bioconjugate polymer

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Dr. Wei Zhang (<https://sciprofiles.com/profile/617712>)

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Section Editor-in-Chief

State Key Laboratory of Polymer Materials Engineering, Polymer Research Institute at Sichuan University, Chengdu 610065, China

Interests: nanofibers; UHMWPE fibers; electrospinning; gel spinning; 3D printing; polymer composites; water treatment; biomaterials; energy storage materials

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Prof. Dr. Sixun Zheng (<https://sciprofiles.com/profile/1262222>)

Website (<https://scce.sjtu.edu.cn/en/jiaoshi.php?aid=51&c=3>)

Section Editor-in-Chief

Department of Polymer Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, China

Interests: microphase separation and self-assembly in multicomponent polymer systems; synthesis and characterization of polyhedral oligomeric silsesquioxane (POSS) monomers and POSS-containing polymers; shape memory, self-healing, and reprocessing properties of polymers; dynamics of polymers in bulk by solid NMR spectroscopy (1H, 13C, 29Si, 15N and 2H NMR)

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Dr. Ilaria Armentano (<https://sciprofiles.com/profile/479040>)

Website (<http://unitus-public.gomp.it/Docenti/Render.aspx?UID=6f822dd4-c2cc-4a08-a47e-075feaa3dd6e>)

Advisory Board Member

Department of Economics, Engineering, Society and Business Organization (DEIM), University of Tuscia, 01100 Viterbo, Italy

Interests: carbon nanotubes; biomaterials; polymer nanocomposites; surface properties; tissue engineering; biodegradable polymers

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Prof. Dr. Jean-François Carpentier (<https://sciprofiles.com/profile/12001>)

Website (<http://scienceschimiques.univ-rennes1.fr/catalyse/carpentier/index.html>)

Advisory Board Member

Institute of Chemistry, Organometallics: Materials and Catalysis Group, UMR 6226, University of Rennes, 1 – 35042 Rennes Cedex, France

Interests: metal-based polymerization catalysis; coordination-insertion polymerization; metallocenes; post metallocene catalysts; stereoselective polymerization; polyolefins; ring-opening polymerization; chemical modification of polymers



Dr. Seth B. Darling (<https://sciprofiles.com/profile/12022>)

Website (<http://nano.anl.gov>)

Advisory Board Member

Argonne National Laboratory, Institute for Molecular Engineering, 9700 S. Cass Ave., Argonne, IL 60439, USA

Interests: block copolymers; self-assembly; membranes; sequential infiltration synthesis; sorbents



Prof. Dr. Ana María Díez-Pascual (<https://sciprofiles.com/profile/268042>)

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Advisory Board Member

Analytical Chemistry, Physical Chemistry and Chemical Engineering Department, Faculty of Sciences, Alcalá de Henares, Madrid, Spain

Interests: nanomaterials; polymers; nanocomposites; inorganic nanoparticles; antibacterial agents; surfactants; interphases

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Prof. Dr. Kurt E. Geckeler (<https://sciprofiles.com/profile/11701>)

Website (https://www.researchgate.net/profile/Kurt_Geckeler)

Advisory Board Member

Department of Nanobio Materials and Electronics (DNE), World-Class University Program (WCU), and Department of Materials Science and Engineering, Gwangju Institute of Science & Technology (GIST), 1 Oryong-dong, Buk-gu Gwangju 500-712, Korea

Interests: bionanomaterials; inorganic nanotubes and nanoparticles; nanomedicine; nanostructured polymers; nanosized molecular architectures; supramolecular polymers; biomedical and biocompatible polymers; drug delivery systems; functional polymers; polymer-metal complexes; conducting polymers; stimuli-sensitive materials; chemosensors; polymers for environmental remediation

Prof. Dr. A. Richard Horrocks (<https://sciprofiles.com/profile/187024>)

Website (<http://www.bolton.ac.uk/IMRI/Staff/StaffPages/ProfessorRichardHorrocks.aspx>)

Advisory Board Member

Institute for Materials Research and Innovation, University of Bolton, Bolton BL3 5AB, UK

Interests: burning behaviour of fibres and textiles; flame retardant and heat resistant fibres and textiles; flame retardant advanced materials; degradation and durability of natural and synthetic fibre-containing textiles; degradation and durability of polymers related to textiles

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Prof. Dr. Shan-hui Hsu (<https://sciprofiles.com/profile/779389>)

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Advisory Board Member

Institute of Polymer Science and Engineering, National Taiwan University, Taipei, Taiwan

Interests: biomaterials; tissue engineering; nanobiomaterials

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Prof. Dr. Sebastien Lecommandoux (<https://sciprofiles.com/profile/12103>)

Website (<http://www.lcipo.fr/>)

Advisory Board Member

Laboratoire de Chimie des Polymères Organiques (LCPO), Bordeaux-INP, Université de Bordeaux, CNRS, 16 avenue Pey Berland, CEDEX, 33607 Pessac, France

Interests: block copolymer self-assembly; stimuli-responsive nanostructures; polymersomes; hybrid polymer/nanoparticles structures; therapeutic applications; drug delivery systems; theranostics

Prof. Dr. Quan Li (<https://sciprofiles.com/profile/2217685>)

Website (<http://www.quanlib.com>)

Advisory Board Member

Institute of Advanced Materials and School of Chemistry and Chemical Engineering, Southeast University, Nanjing, China

Interests: stimuli-responsive smart soft matter; advanced photonics; optoelectronic materials for energy harvesting; energy saving to functional biocompatible materials; nanoparticles to nanoengineering



Prof. Dr. Katja Loos (<https://sciprofiles.com/profile/13141>)

MDPI (<https://www.rug.nl/staff/k.u.loos/>)

Advisory Board Member

Macromolecular Chemistry and New Polymeric Materials, Zernike Institute for Advanced Materials, University of Groningen, Nijenborgh 4, 97120 Groningen, The Netherlands

Interests: biocatalysis in polymer chemistry; enzymatic polymerizations; green polymer chemistry; biocatalytic monomer synthesis; biocatalytic polymer modification; enzyme immobilization; unraveling the mechanism of biocatalytic polymerizations; biobased monomers and polymers; sustainability; polysaccharides; starch; anionic polymerization; controlled radical polymerization; block copolymer synthesis; supramolecular assembly; block copolymer self-assembly

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Prof. Dr. Nadia Lotti (<https://sciprofiles.com/profile/127609>)

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Advisory Board Member

1. Department of Civil, Chemical, Environmental and Materials Engineering of the University of Bologna, Bologna, Italy
2. Industrial Research Advanced Materials for the Design and Photonic Applications (CIRI-MAM), University of Bologna, Bologna, Italy
3. Interdepartmental Centre of Industrial Agrifood Research (CIRI-Agrifood), University of Bologna, Bologna, Italy

Interests: eco-friendly polymers for sustainable food packaging, green building and coatings; synthesis and characterization of novel polymeric materials for biomedical applications; study of polymer crystallization process; complex analyses of dynamic phenomena and of polymeric material structure; preparation and characterization of "eco-friendly nanocomposites" for food packaging and biomedical applications; synthesis and characterization of novel S-S containing polyesters; synthesis and characterization of bio-based polyureas; valorization of agro-food waste; biodegradation studies in soil, marine environment and compost

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Ian Manners

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Advisory Board Member

Department of Chemistry, University of Victoria, Victoria, BC V8W 3 V6, Canada

Interests: polymer and materials science; catalysis; self-assembly; nanoscience; inorganic chemistry



Prof. Dr. Krzysztof Matyjaszewski (<https://sciprofiles.com/profile/640541>)

★ (<https://clarivate.com/highly-cited-researchers/2022/>) **Website** (<https://www.cmu.edu/maty/>)

Advisory Board Member

Department of Chemistry, Carnegie Mellon University, Pittsburgh, PA 15213, USA

Interests: chemistry; polymers; polymer chemistry; polymer science; materials



Prof. Dr. David Mecerreyes (<https://sciprofiles.com/profile/76670>)

Website (<http://www.polymat.eu/en/people/jefes-de-grupo/david-mecerreyes>)

Advisory Board Member

POLYMAT, Joxe Mari Korta Center, University of the Basque Country UPV/EHU, Avda. Tolosa 72, 20018 Donostia-San Sebastian, Spain

Interests: Innovative polymer chemistry; polymeric ionic liquids; redox polymers; polymers for energy (batteries)

Special Issues, Collections and Topics in MDPI journals

Prof. Dr. Goerg H. Michler (<https://sciprofiles.com/profile/11662>)

Website (<http://www.physik.uni-halle.de/aww/index.htm>)

Advisory Board Member

Institut für Polymerwerkstoffe e.V. (IPW), Eberhard-Leibnitz-Straße 2, D-06217 Merseburg/Saale, Germany

Interests: electron microscopy (including SEM, TEM); atomic force microscopy (AFM); morphology of polymers; micromechanical properties; nanostructured polymers; toughness enhancement; nanocomposites; biomedical polymers



Prof. Dr. Kell Mortensen

Website (<http://www.nbi.dk/~kell/>)

Advisory Board Member

Niels Bohr Institute, University of Copenhagen, Universitetsparken 5, 2100 Copenhagen, Denmark

Interests: materials sciences; biomolecules and polymers; molecular self-assembly; soft matter science; biomembrane; synthetic biology; X-ray and neutron scattering



Prof. Dr. Klaus Müllen (<https://sciprofiles.com/profile/11661>)

★ (<https://recognition.webofsciencegroup.com/awards/highly-cited/2020/>) **Website** (<https://www.mpg.de/369516/polymer-research-muellen>)

Advisory Board Member

Max Planck Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz, Germany

Interests: new polymer-forming reactions including methods of organometallic chemistry; multi-dimensional polymers with complex shape-persistent architectures; functional polymeric networks, in particular for catalytic purposes; dyes and laser writing into polymers; chemistry and physics of single molecules; molecular materials with liquid crystalline properties for electronic and optoelectronic devices; materials for lithium or hydrogen storage; biosynthetic hybrids; nanocomposites

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Chul B. Park (<https://sciprofiles.com/profile/373871>)

Website (https://www.mie.utoronto.ca/faculty_staff/park/)

Advisory Board Member

Department of Mechanical and Industrial Engineering, University of Toronto, 5 King's College Road, Toronto, ON M5S 3G8, Canada

Interests: plastic foaming technology; fundamental understanding of foaming phenomena; computational modeling of foaming; super high R value foams; sound insulation foams, biodegradable foams; environmentally safe blowing agents

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Polycarpos Pissis (<https://sciprofiles.com/profile/12048>)

Website (<http://www.physics.ntua.gr>)

Advisory Board Member



Dr. Debora Puglia (<https://sciprofiles.com/profile/283177>)

Website1 (https://www.researchgate.net/profile/Debora_Puglia) **Website2** (https://scholar.google.com/citations?hl=it&user=pPws5pQAAAAJ&view_op=list_works&sortby=pubdate)

Advisory Board Member

Civil and Environmental Engineering Department, UdR INSTM, University of Perugia, Strada di Pentima 4, 05100 Terni, Italy

Interests: bionanocomposites; natural fibers composites; lignin nanoparticles; nanocellulose; active packaging; polymeric nanocomposites

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Marguerite Rinaudo (<https://sciprofiles.com/profile/75662>)

Advisory Board Member

Biomaterials Applications, University of Grenoble Alpes, 6 Rue Lesdiguières, 38000 Grenoble, France

Interests: investigation on properties and applications of polysaccharides and water-soluble polymers; specific chemical modifications of polysaccharides and production of adaptative materials; electrostatic properties and polyelectrolytes properties; hydration of polysaccharides in relation with their chemical structure and their environment; polyelectrolyte complexes; rheology in solution and gel states; polysaccharides-surfactant interactions; decoration and stabilization of liposomes with polyelectrolytes; biomaterials from polysaccharides; applications of polysaccharides in cosmetics, foods, biomedical (drug release)

Special Issues, Collections and Topics in MDPI journals

Prof. Dr. Ulrich S. Schubert (<https://sciprofiles.com/profile/11707>)

★ (<https://recognition.webofscience.com/awards/highly-cited/2021/>) **Website** (<http://www.schubert-group.de>)

Advisory Board Member

Laboratory of Organic and Macromolecular Chemistry (IOMC) Jena Center for Soft Matter (JCSM), Friedrich-Schiller-Universität Jena, Humboldtstr. 10, D-07743 Jena, Germany

Interests: automatization; coordination chemistry; drug delivery; functional polymers; inkjet printing; metallo-supramolecular polymers; polymer batteries; polymer nanoparticles; self-healing materials

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Eric Shaqfeh (<https://sciprofiles.com/profile/11706>)

Website (<http://antares.stanford.edu/>)

Advisory Board Member

Departments of Chemical and Mechanical Engineering, Stanford University, Stanford, CA 94305-5025, USA

Interests: transport mechanics of complex fluids; turbulent drag reduction; dynamics of suspensions of anisotropic and deformable particles in suspension; DNA dynamics in mixed flows and in micro- and macro- devices; DNA dynamics in microfluidic devices; polymer dynamics in concentrated solutions; polymer conformational hysteresis in mixed flows



Prof. Dr. John T. Sheridan (<https://sciprofiles.com/profile/18041>)

Website (<http://www.ucd.ie/biomedicalengineering/people/engineeringprincipalinvestigators/sheridanprofjohn/>)

Advisory Board Member

UCD School of Electrical, Electronic and Mechanical Engineering, University College Dublin, Belfield, Dublin 4, Ireland

Interests: photo-polymerisation; photo-polymers; dye sensitised polymers; PQ/PMMA; optical applications of polymers including: holography, waveguides, gratings

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Nico A. J. M. Sommerdijk (<https://sciprofiles.com/profile/2283>)

Website (<http://www.cryotem.nl/>)

Advisory Board Member

Laboratory of Materials and Interface Chemistry and Soft Matter CryoTEM Research Unit, Department of Chemical Engineering and Chemistry, and Institute for Complex Molecular Systems Eindhoven University of Technology, 5600 MB Eindhoven, The Netherlands

Interests: biomimetic materials; biomineralization; polymer self-assembly; cryoTEM; cryo-electron tomography

Dr. Gila E. Stein (<https://sciprofiles.com/profile/375633>)

Website (<http://cbe.utk.edu/people/gila-e-stein/>)

Advisory Board Member

Department of Chemical & Biomolecular Engineering The University of Tennessee, Knoxville 431 Dougherty Engineering Building 1512 Middle Drive, Knoxville, TN 37996-2200, USA

Interests: polymer thin films; block copolymers; directed self assembly; lithography; organic photovoltaics



Prof. Dr. Brent S. Sumerlin

Website (<https://sumerlin.chem.ufl.edu/people.html>)

Advisory Board Member

Department of Chemistry, University of Florida, Gainesville, FL, USA

Interests: functional polymer synthesis and efficient polymer modification via specific and orthogonal methodologies; stimuli-responsive water-soluble block copolymers; dynamic-covalent macromolecular materials; smart polymer-protein bioconjugates



Prof. Dr. Andreas Taubert (<https://sciprofiles.com/profile/10641>)

Website (<http://www.taubert-lab.net/>)

Advisory Board Member

Institute of Chemistry, University of Potsdam, Building 25, Rm. B.0.17-17, Karl-Liebknecht-Str. 24-25, D-14476 Golm, Germany

Interests: inorganic materials synthesis in ionic liquids; functional ionic liquids-hybrid materials; ionogels; biomimetic materials; hybrid materials; calcium phosphate; silica; water treatment; energy materials

Special Issues, Collections and Topics in MDPI journals






Prof. Dr. Manuel Toledano (<https://sciprofiles.com/profile/1488780>)

Website1 (<https://www.ugr.es/personal/b2056462fb278ce2229b3b2487d93b36>) **Website2** (https://www.researchgate.net/profile/Manuel_Toledano3)

Advisory Board Member

Department of Dental Materials, School of Dentistry, University of Granada, Granada, Spain

 (toggle desktop layout cookie)  

Interests: hard and soft tissue regeneration in the oral cavity; polymers for tissue engineering



Prof. Dr. Maria Vamvakaki (<https://sciprofiles.com/profile/14352>)

Website (<https://www.materials.uoc.gr/en/general/personnel/vamvakak.html>)

Advisory Board Member

1. Department of Materials Science and Technology, University of Crete, 70013 Heraklion, Greece 2. Institute of Electronic Structure and Laser (IESL), Foundation for Research and Technology Hellas (FORTH), 70013 Heraklion, Greece

Interests: Stimuli-responsive; "smart" and functional polymers; self-assembly

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Gyula Julius Vancso

Website (<http://g.j.vancso.nl>)

Advisory Board Member

Faculty of Science and Technology, MESA+ Research Institute for Nanotechnology, University of Twente, P. O. Box 217, 7500 AE Enschede, the Netherlands

Interests: stimulus responsive polymers; macromolecular nanotechnology; surface engineering and analysis; polymer characterization; atomic force microscopy

Prof. Dr. Cornelia Vasile (<https://sciprofiles.com/profile/210316>)

Website1 (<https://www.researchgate.net/profile/Cornelia-Vasile>) **Website2** (<https://orcid.org/0000-0003-1854-0278>)

Advisory Board Member

Romanian Academy, "P.Poni" Institute of Macromolecular Chemistry, Physical Chemistry of Polymers Department, 41A Gr. Ghica Voda Alley, RO 700487 Iasi, Romania

Interests: polymeric (bionano)composites; biomaterials; biodegradation; polymer compatibility and biocompatibility; kinetics and thermodynamics of polymeric systems; food packaging, (active, bioactive, smart, (bio)degradable); drugs delivery; recovery of polymer wastes by destructive and non-destructive procedures; environmental pollution and protection; smart polymers

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Jin-Rae Cho (<https://sciprofiles.com/profile/789438>)

Website (<https://scholar.google.com/citations?user=oMQ5MJMAAAAJ&hl=en>)

Editorial Board Member

Department of Naval Architecture and Ocean Engineering, Hongik University, Jochiwon, Sejong 30016, Korea

Interests: functionally graded materials (FGM); CNT-reinforced polymers; FG-CNTRC structures; automotive tyres; fiber-reinforced elastomer; LNG containment



Dr. Raluca-Nicoleta Darie-Nita (<https://sciprofiles.com/profile/502016>)

Website (<https://www.researchgate.net/profile/Raluca-Darie-Nita>)

Editorial Board Member

Physical Chemistry of Polymers Department, Petru Poni Institute of Macromolecular Chemistry, 700487 Iasi, Romania

Interests: biopolymers; reactive processing (natural and synthetic polymers); physico-chemical characterization of polymers and composites (rheological, mechanical, thermal, surface properties); applications of bio-based materials

Special Issues, Collections and Topics in MDPI journals



Dr. Masayoshi Higuchi (<https://sciprofiles.com/profile/1298341>)

Website (https://samurai.nims.go.jp/profiles/HIGUCHI_Masayoshi?locale=en)

Editorial Board Member

National Institute for Materials Science Tsukuba, Research Center for Functional Materials, Tsukuba, Japan

Interests: electrochromic devices; electropolymerization; metallo-supramolecular polymer; coordination polymers; organic/metal hybrid polymer composites

Dr. Yang Li (<https://sciprofiles.com/profile/620365>)

Website (https://www.researchgate.net/profile/Yang_Li258)

Editorial Board Member

School of Materials Science and Engineering, Tianjin University, Tianjin 300354, China

Interests: carbon-fiber-reinforced composites; ultrasonic welding; ultrasonic additive manufacturing; resistance welding dissimilar materials joining; lightweight materials joining

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Zhan Lin

★ (<https://clarivate.com/highly-cited-researchers/2022>) **Website** (http://www.eneelab.com/redis.php?catalog_id=17620)

Editorial Board Member

Guangzhou Key Laboratory of Clean Transportation Energy Chemistry, School of Chemical Engineering and Light Industry, Guangdong University of Technology, Guangzhou 510006, China

Interests: energy storage & catalysis



Prof. Dr. Xiaoyun Liu

Website (<http://liuxiaoyun.polymer.cn>)

Editorial Board Member

Laboratory of Specially Functional Polymeric Materials and Related Technology (ECUST), Ministry of Education, East China University of Science and Technology, Shanghai, China

Interests: polymer chemistry; high performance polymer



Prof. Dr. Francesco Lopresti (<https://sciprofiles.com/profile/418194>)

Website (<https://www.researchgate.net/profile/Francesco-Lopresti-2>)

Editorial Board Member

Department of Engineering, University of Palermo, RU INSTM, Viale delle Scienze, Palermo, Italy Viale delle Scienze – Parco d'Orleans II, Ed. 6, 90128 Palermo, Italy

Interests: biopolymers; tissue engineering; nanomaterials; electrospinning; tissue regeneration; biocompatible materials; scaffold development; biomaterial functionalization

Prof. Dr. Libo Yan (<https://sciprofiles.com/profile/147437>)

MDPI
Website (<https://www.wki.fraunhofer.de/en/departments/zeluba/profile/bmel-fnr-junior-research-group.html>)

Editorial Board Member

1. Division of Organic and Wooden Based Materials, Institute of Building Materials, Concrete Construction and Fire Safety, Technische Universität Braunschweig, Germany

2. Fraunhofer Institute for Wood Research Wilhelm-Klauditz-Institut WKI, 38108 Braunschweig, Germany

Interests: FRP; fibre reinforced concrete; wood science; bio-composites; hybrid structures; durability of materials; dynamics of structures; recycling and reuse of construction and demolition; agricultural and forestry, and plastic wastes; thermal and fire performance of materials

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Richard (Chunhui) Yang (<https://sciprofiles.com/profile/950944>)

Website (https://www.westernsydney.edu.au/staff_profiles/uws_profiles/professor_richard_yang)

Editorial Board Member

School of Engineering, Design and Built Environment, Western Sydney University, Penrith, NSW 2751, Australia

Interests: additive manufacturing, advanced manufacturing, and industry 4.0; multiscale modelling and simulations of advanced engineering materials and structures; engineering numerical methods and their applications; digital material representation, fabrication, and characterization of materials; structural health monitoring and smart structures; machine condition monitoring and smart machines; sheet metal forming; metal surface treatment and coating; polymer composites, nanocomposites, and conductive polymers; metal foams; mechanical design and product development

Special Issues, Collections and Topics in MDPI journals

Prof. Dr. Wenbin Zhong

Website (<http://grjl.hnu.edu.cn/p/81BD83D502DAC9DD1E58F080EE2ECB4E>)

Editorial Board Member

College of Materials Science and Engineering, Hunan University, Changsha 410082, China

Interests: polymer materials; supramolecular assembly; advanced energy materials



Dr. Ahmed I. A. Abd El-Mageed (<https://sciprofiles.com/profile/1061142>)

Website (<https://www.gu.edu.eg/ahmed-ibrahim/>)

Section Board Member

Chemistry Department, Faculty of Science, GALALA University, Al Galala, Egypt

Interests: supramolecular chemistry on nano-carbon materials surfaces; carbon nanotubes and/or graphite research; single molecule magnets; self-assembly of nanostructures on solid surfaces; fabrication of nano-scale devices that employ the self-ordering properties of molecules; pickering Emulsion Polymerization; colloidal nanotechnology; nanoparticles stabilized emulsions; hybrid inorganic-organic nano-materials; SPM measurements i.e. STM, AFM



Prof. Dr. Dimitris S. Achillas (<https://sciprofiles.com/profile/16989>)

Website (<https://www.chem.auth.gr/en/staff/dachillas/>)

Section Board Member

Department of Chemistry, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

Interests: polymerization kinetics; thermal degradation kinetics; modeling of radical and step polymerization reactions; polymer nanocomposites; calorimetry; polymer recycling

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Grażyna Adamus (<https://sciprofiles.com/profile/486243>)

Website (https://scholar.google.pl/citations?hl=pl&user=ORCEc3AAAAAJ&view_op=list_works&sortby=pubdate)

Section Board Member

Centre of Polymer and Carbon Materials, Polish Academy of Sciences, M. Curie-Skłodowskiej 34, 41-819 Zabrze, Poland

Interests: polymers from renewable resources; synthesis of functional polymers; structure–property relationships; novel polymeric materials of controlled biodegradability; application of mass spectrometry techniques to the structural study of synthetic polymers at the molecular level

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Maricel Agop (<https://sciprofiles.com/profile/1147330>)

Website (<https://www.phys.uaic.ro/index.php/en/scoala-doctorala-en/conducatori-doctorat-en/maricel-agop-expertiza-en/>)

Section Board Member

Department of Materials Science, Gheorghe Asachi Technical University of Iasi, 700050 Iasi, Romania

Interests: drug delivery; fractal physics; non-linear dynamics; theoretical non-differentiable physics; polymer dynamics

Special Issues, Collections and Topics in MDPI journals

Prof. Dr. Shahzada Ahmad (<https://sciprofiles.com/profile/459938>)

Website (<https://www.ikerbasque.net/en/shahzada-ahmad>)

Section Board Member

BCMaterials - Basque Center for Materials Applications & Nanostructures, 48940 Leioa, Bizkaia, Spain

Interests: semiconducting polymers; ion conducting polymers; polymer electrolytes; conducting polymers



Prof. Dr. Marya Ahmed (<https://sciprofiles.com/profile/238647>)

Website (<http://ahmedmarya.wixsite.com/research/about-me>)

Section Board Member

Faculty of Sustainable Design & Engineering, University of Prince Edward Island, Charlottetown, PE C1A 4P3, Canada

Interests: peptide-polymer hybrids; hydrogels; self-assembly; drug delivery; antibacterial properties

Special Issues, Collections and Topics in MDPI journals



Dr. Guillermo Ahumada (<https://sciprofiles.com/profile/1707716>)

Website1 (https://softmatt.ibs.re.kr/bbs/board.php?bo_table=r fellow&wr_id=122) **Website2** (<https://orcid.org/0000-0002-1507-0816>)

Section Board Member

Korean Institute for Basic Science, Center for Soft and Living Matter, Ulsan National Institute of Science and Technology, Ulsan, Korea

Interests: inorganic; organic; polymer and organometallic chemistry; homogeneous catalysis (metathesis); electrochemistry (electrocatalysis and electropolymerization); single crystal X-ray crystallography (growth, measurement, and resolution of crystal structures); computational chemistry

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Mohamad Al-Sheikhly (<https://sciprofiles.com/profile/351962>)

Website (<https://mse.umd.edu/clark/faculty/637/Mohamad-Al-Sheikhly>)

Section Board Member

Laboratory for Radiation and Polymer Science, Department of Materials Science and Engineering, A. J. Clark School of Engineering, University of Maryland, College Park, MD 20742-2115, USA

Interests: polymers; biomaterials; radiation engineering; nuclear engineering; environmental effects

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Rufina G. Alamo (<https://sciprofiles.com/profile/1214452>)

Website (<https://www.eng.famu.fsu.edu/cbe/people/alamo>)

Section Board Member

Department of Chemical Engineering, FAMU-FSU College of Engineering, Tallahassee, FL 32310, USA

Interests: polymer crystallization; polymorphism; crystallization and melting of polyethylenes and polypropylenes; morphological and structural studies in polyolefins; blends of polyolefins

Special Issues, Collections and Topics in MDPI journals



Dr. Antonino Alessi (<https://sciprofiles.com/profile/761413>)

Website (https://www.researchgate.net/profile/A_Alessi)

Section Board Member

Laboratoire des Solides irradiés, CEA/DRF/IRAMIS, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, Route de Saclay, F-91128 Palaiseau, France

Interests: optical fibers; radiation-matter interactions; glasses; point defects; magnetic and optical properties; nano-systems; material characterization

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Paschalis Alexandridis (<https://sciprofiles.com/profile/12240>)

Website (<http://www.cbe.buffalo.edu/alexandridis>)

Section Board Member

Department of Chemical and Biological Engineering, University at Buffalo, The State University of New York (SUNY), Buffalo, NY 14260-4200, USA

Interests: self-assembly; directed assembly; surfactants; block copolymers; polysaccharides; nanoparticles; water; ionic liquids; formulations; polymer dissolution

Special Issues, Collections and Topics in MDPI journals



Dr. Hisham A. Alhadlaq (<https://sciprofiles.com/profile/906253>)

Website (<https://faculty.ksu.edu.sa/ar/node/140141>)

Section Board Member

Department of Physics and Astronomy and King Abdullah Institute for Nanotechnology, King Saud University, Riyadh 11451, Saudi Arabia

Interests: nanomedicine; nanoparticle toxicity; cancer biology; targeted therapy; cancer cell

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Moonis Ali Khan (<https://sciprofiles.com/profile/967581>)

Website (<https://www.researchgate.net/profile/Moonis-Khan>)

Section Board Member

Chemistry Department, College of Science, King Saud University, Riyadh 11451, Saudi Arabia

Interests: heavy metals; adsorption; kinetic modeling; carbon nanotubes; coating; water and wastewater treatment; oxidation; catalysis; photocatalysis; phycoremediation; biochar; hydrochar; graphene; CNTs; activated carbon; biofuel

Special Issues, Collections and Topics in MDPI journals



Dr. Jenny Alongi (<https://sciprofiles.com/profile/96227>)

Website (<https://www.unimi.it/en/ugov/person/jenny-alongi>)

Section Board Member

Dipartimento di Chimica, University of Milan, via C. Golgi 19, 20133 Milano, Italy

Interests: polymers with high thermal stability; flame-retardant polymers; biocompatible and biomimetic polymers; multifunctional resins for the adsorption of heavy metals from wastewaters; multifunctional coatings; layer-by-layer assembly

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Volker Altstädt (<https://sciprofiles.com/profile/182861>)

Website (<https://www.polymer-engineering.de/en/about-us/our-team/>)

Section Board Member

Department of Polymer Engineering, University of Bayreuth, 95444 Bayreuth, Germany

Interests: environmentally friendly polymers; lightweight materials; functional polymers; advanced processing & testing

Special Issues, Collections and Topics in MDPI journals



Dr. Luis Alves (<https://sciprofiles.com/profile/771105>)

Website (<https://www.cienciavita.pt/portal/8F17-D792-3D18>)

Section Board Member

CIEPQPF—Chemical Process Engineering and Forest Products Research Centre, Department of Chemical Engineering, University of Coimbra, Rua Silvio Lima, 3030-790 Coimbra, Portugal

Interests: cellulose chemistry; cellulose dissolution and regeneration; nanocellulose production and characterization; cellulose and nanocellulose-based organic-inorganic hybrid materials; bio-based polyelectrolytes from lignocellulosic materials; lignin-based materials; rheology; surfactants; polymer-surfactant association; microscopy

Special Issues, Collections and Topics in MDPI journals



Dr. Amir Ameli (<https://sciprofiles.com/profile/573318>)

MDPI
Website (<https://www.uml.edu/Engineering/Plastics/Faculty-Staff/faculty/Ameli-Amir.aspx>)

Section Board Member

Department of Plastics Engineering, University of Massachusetts Lowell, 1 University Avenue, Ball Hall, Room 202A Lowell, MA 01854, USA   

Interests: multifunctional polymer nanocomposites; additive manufacturing; bioproducts; smart materials and structures; advanced polymer-based foams; mechanics of materials

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Brian G. Amsden (<https://sciprofiles.com/profile/1783235>)

Website (<https://chemeng.queensu.ca/people/Faculty/BrianAmsden/>)

Section Board Member

Department of Chemical Engineering, Queen's University at Kingston, Kingston, ON K7L 3N6, Canada

Interests: biodegradable and biocompatible polymers for biomedical applications; ocular drug delivery; tissue engineering; scaffolds



Prof. Dr. Qiaoshi An

★ (<https://clarivate.com/highly-cited-researchers/2022>) **Website** (<https://scholar.google.com/citations?user=cCFy3EAAAAJ&hl=zh-CN>)

Section Board Member

School of Chemistry and Chemical Engineering, Beijing Institute of Technology, Beijing 100081, China

Interests: organic photovoltaic materials and devices

Special Issues, Collections and Topics in MDPI journals



Dr. Seongpil An (<https://sciprofiles.com/profile/398865>)

Website (<http://sites.google.com/view/seongpilan>)

Section Board Member

SKKU Advanced Institute of Nanotechnology (SAINT) & Department of Nano Engineering, Sungkyunkwan University, Suwon, Korea

Interests: artificial/natural polymers; electrospinning; solution blowing; polymer/carbon/metal/ceramic fibers; transparent conducting film; vascular self-healing system; soft actuator; triboelectric/piezoelectric nanogenerator; cooling film; water/air purification membranes

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Spiros H. Anastasiadis (<https://sciprofiles.com/profile/234903>)

Website (<https://www.iesl.forth.gr/en/people/anastasiadis-spiros>)

Section Board Member

Institute of Electronic Structure and Laser, Foundation for Research and Technology-Hellas, N. Plastira 100, 700 13 Heraklion Crete, Greece

Interests: polymer surfaces and interfaces and thin films; polymer blends and homopolymer / copolymer blends; dynamics and diffusion in multiconstituent systems; organic/inorganic nanohybrid materials; responsive polymer systems

Special Issues, Collections and Topics in MDPI journals



Dr. Roberta Angelini (<https://sciprofiles.com/profile/1506707>)

Website1 (<https://www.isc.cnr.it/staff-members/roberta-angelini/>) **Website2** (<https://www.roma1.infn.it/~angerob/>)

Section Board Member

Istituto dei Sistemi Complessi del Consiglio Nazionale delle Ricerche (ISC-CNR), Sede Sapienza, 00185 Roma, Italy

Interests: soft matter; colloids; polymers; structure; dynamics; glasses; gels; experiments; scattering techniques; rheology; calorimetry

Special Issues, Collections and Topics in MDPI journals



Dr. Diego Antonioli (<https://sciprofiles.com/profile/482601>)

Website (<http://www.michelelaus.it/people/>)

Section Board Member

Department of Science and Technological Innovation, Università del Piemonte Orientale "A. Avogadro", Viale T. Michel 11, 15121 Alessandria, Italy

Interests: block copolymer; self-assembly; nanocomposites; nanotechnology; polymer nanoparticles; thermal properties; dynamic-mechanical and mechanical properties



Prof. Dr. Marcelo Antunes (<https://sciprofiles.com/profile/353317>)

Website1 (<https://www.researchgate.net/profile/Marcelo-Antunes-6>) **Website2** (<https://directori.upc.edu/directori/dadesPersona.jsp?id=1049816>)

Section Board Member

Department of Materials Science and Engineering, Poly2 Group, Technical University of Catalonia (UPC BarcelonaTech), ESEIAAT, C/Colom 11, 08222 Terrassa, Spain

Interests: additives; aerogels; composites; conductivity; extrusion; films; foaming; foams; foils; fracture; graphene; ignifugation; membranes; molding; nanocomposites; nanoparticles; oxides; permeability; polyfunctional materials; polymers; processing; properties; resistance; silicates; structure; supercritical fluid

Special Issues, Collections and Topics in MDPI journals



Dr. Waldo M. Argüelles-Monal (<https://sciprofiles.com/profile/312589>)

Website (<https://www.scopus.com/authid/detail.uri?authorid=55995932600>)

Section Board Member

Biopolymers Group, Centro de Investigación en Alimentación y Desarrollo, Hermosillo, Sonora 83304, Mexico

Interests: polysaccharides and their derivatization; polyelectrolyte complexes; smart polymers; functional polymeric materials and nanomaterials for biomedical and biotechnological applications

Special Issues, Collections and Topics in MDPI journals



Dr. Mohammad Arjmand (<https://sciprofiles.com/profile/615627>)

Website (<https://ok-npnl.sites.olt.ubc.ca>)

Section Board Member

School of Engineering, University of British Columbia, Kelowna, BC V1V 1V7, Canada

Interests: nanomaterials synthesis; carbon nanotube; graphene; metal-organic framework; MXene; polymer processing; multifunctional polymer nanocomposites; gas sensors;



Dr. Marina Patricia Arrieta Dillon (<https://sciprofiles.com/profile/414499>)

Website (<http://polca.upm.es/index.php/en/members/>)

Section Board Member

Department of Industrial and Environmental Chemical Engineering, E.T.S.I. Industriales, Technical University of Madrid, Madrid, Spain

Interests: food packaging; biobased and/or biodegradable polymers; nanocomposites; active materials; waste valorization; mechanical recycling; compostability.

Special Issues, Collections and Topics in MDPI journals



Dr. Rossella Arrigo (<https://sciprofiles.com/profile/336727>)

Website ([https://www.disat.polito.it/personale/scheda/\(nominativo\)/rossella.arrigo](https://www.disat.polito.it/personale/scheda/(nominativo)/rossella.arrigo))

Section Board Member

Politecnico di Torino, Department of Applied Science and Technology, Viale Teresa Michel 5, 15121 Alessandria, Italy

Interests: processing of polymers and biopolymers; polymer-based complex systems; polymer-based composites and nanocompo-sites; rheological behavior; structure-property relationships

Special Issues, Collections and Topics in MDPI journals



Dr. Prashanth Asuri (<https://sciprofiles.com/profile/416151>)

Website (<https://www.scu.edu/engineering/faculty/asuri-prashanth/>)

Section Board Member

Department of Bioengineering, School of Engineering, Santa Clara University, 500 El Camino Real, Santa Clara, CA 95053, USA

Interests: biomaterials engineering; hydrogel nanocomposites; in vitro cell culture platforms; protein structure and function

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Leonard Ionut Atanase (<https://sciprofiles.com/profile/13622>)

Website (<https://www.researchgate.net/profile/Leonard-Atanase>)

Section Board Member

Faculty of Medical Dentistry, "Apollonia" University of Iasi, 700511 Iasi, Romania

Interests: block and graft copolymers; micelles; colloids; emulsions; drug delivery; polysaccharides

Special Issues, Collections and Topics in MDPI journals



Dr. Günter K. Auernhammer

Website (<https://www.ipfdd.de/en/organization/personal-homepages/dr-guenter-k-auernhammer/>)

Section Board Member

Leibniz-Institut für Polymerforschung Dresden e.V., Institut für Physikalische Chemie und Physik der Polymere, 01069 Dresden, Germany

Interests: fluid mechanics; physical chemistry; experimental physics; fluid dynamics; condensed matter physics; polymers; surface science



Prof. Dr. Rafael Auras (<https://sciprofiles.com/profile/339365>)

Website (https://www.canr.msu.edu/people/auras_rafael)

Section Board Member

Department of Microbiology and Molecular Genetics, Biomedical & Physical Sciences, Michigan State University, East Lansing, MI 48824-1223, USA

Interests: polymers; poly(lactic acid); packaging; biodegradation; life cycle assessment

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Luc Avérous (<https://sciprofiles.com/profile/197785>)

Website (<https://www.biodeg.net/>)

Section Board Member

BioTeam/ICPEES-ECPM, UMR CNRS 7515, Université de Strasbourg, 25 rue Becquerel, CEDEX 2, 67087 Strasbourg, France

Interests: biobased polymers; biodegradable polymers; biomaterials; biopolymers; green chemistry



Dr. Francis Aviles (<https://sciprofiles.com/profile/159483>)

Website (<https://www.cicy.mx/sitios/investigador/dr-francis-aviles-cetina>)

Section Board Member

Centro de Investigación Científica de Yucatán A.C., Unidad de Materiales, Calle 43 No. 130 x 32 y 34 Col, Chuburna de Hidalgo, 97205 Mérida, Mexico

Interests: nanostructures; composite fabrication; testing and modelling; with particular interest on carbon nanostructures



Dr. Roberto Avolio (<https://sciprofiles.com/profile/857265>)

Website (<http://www.ipcb.cnr.it/index.php/it/personale/strutturato/65-roberto-avolio>)

Section Board Member

Institute for Polymers, Composites and Biomaterials of the National Research Council of Italy (IPCB-CNR), Via Campi Flegrei 34, 80078 Pozzuoli, Italy

Interests: multiphase polymeric materials; mechanochemical treatments; solid state NMR spectroscopy; recycling and sustainability; biodegradable polymers; composites and nanocomposites

Special Issues, Collections and Topics in MDPI journals



Dr. Shazed Aziz (<https://sciprofiles.com/profile/1362595>)

Website (<https://researchers.uq.edu.au/researcher/24393>)

Section Board Member



Dr. Ki Hyun Bae (<https://sciprofiles.com/profile/1125049>)

Website (<https://www.a-star.edu.sg/lbb/home>)

Section Board Member

Institute of Bioengineering and Bioimaging (IBB), A*STAR (Agency for Science, Technology and Research), Singapore

Interests: biomaterials; biopolymers; hydrogel; nanomedicine; drug delivery system



Prof. Dr. Claudio Baggiani (<https://sciprofiles.com/profile/126610>)

Website (https://www.chimica.unito.it/do/docenti.pl/Show?_id=cbaggian#profilo)

Section Board Member

Department of Chemistry, University of Turin, 10125 Turin, Italy

Interests: molecular imprinting; ion imprinting; molecular recognition; immunoassay

Special Issues, Collections and Topics in MDPI journals



Dr. Vincenzo Baglio (<https://sciprofiles.com/profile/53489>)

Website (<http://www.itae.cnr.it/en/staff/baglio-vincenzo-dafce-manager/>)

Section Board Member

CNR-ITAE Institute for Advanced Energy Technologies "N. Giordano", Via Salita S. Lucia sopra Contesse 5, 98126 Messina, Italy

Interests: polymer electrolyte fuel cells; direct alcohol fuel cells; water electrolysis; metal-air batteries; dye-sensitized solar cells; photo-electrolysis; carbon dioxide electro-reduction

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Matthias Ballauff (<https://sciprofiles.com/profile/1382128>)

Website (<https://akhaag.userpage.fu-berlin.de/group01.html>)

Section Board Member

Institut für Chemie und Biochemie, Freie Universität Berlin, Takustrasse 3, 14195 Berlin, Germany

Interests: physics of colloids and macromolecules; chemistry and physics of colloidal systems; scattering methods and structural research on battery systems was done mainly by using small-angle x-ray and neutro

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Jason Bara (<https://sciprofiles.com/profile/448370>)

Website (<http://jbara.eng.ua.edu/>)

Section Board Member

Department of Chemical and Biological Engineering, University of Alabama, Tuscaloosa, AL 35487-0203, USA

Interests: ionic liquids; high-performance polymers; gas separations; CO₂ capture; membranes; green chemistry; simulations and modeling; big data

Special Issues, Collections and Topics in MDPI journals



Dr. Tamás Bárány (<https://sciprofiles.com/profile/184672>)

Website (<http://www.pt.bme.hu/munkatarsadatlap.php?id=9y2mds2rx4bu78o23u92smfrf7h7955b2h8u6g8&i=a>)

Section Board Member

Department of Polymer Engineering, Faculty of Mechanical Engineering, Budapest University of Technology and Economics, H-1111 Budapest, Műegyetem rkp. 3., Hungary

Interests: self-reinforced and all-polymer composites, thermoplastic elastomers, recycling of polymers and elastomers, polymers and composites from renewable resource, impact testing



Dr. Michel Bardet (<https://sciprofiles.com/profile/448053>)

Website (<https://www.mem-lab.fr/Pages/Portrait/Michel-Bardet.aspx>)

Section Board Member

Modelisation and Exploration of Materials Laboratory, CEA-Grenoble, 17 rue des Martyrs, F-38054 Grenoble, France

Interests: applications and developments of NMR in liquid and solid phases (material for batteries and fuel cells, pyrolyzed and torrefied biomass for energy production, biomass products and their derivatives, archaeological organic materials); development of PFG NMR (size measurements of OB in plant seeds, localized spectroscopy and study of complex fluids); DNP and low temperature NMR; renewable energy and energy transition



Prof. Dr. Regis Barille (<https://sciprofiles.com/profile/248321>)

Website (<http://moltech-anjou.univ-angers.fr>)

Section Board Member

MOLTECH-Anjou Laboratory, UMR CNRS 6200, University of Angers, 2 bd Lavoisier, 49045 Angers CEDEX, France

Interests: polymers; photochromatism; nonlinear optics; AFM; near-field microscopies; surface characterization; thin films



Prof. Dr. Nektaria-Marianthi Barkoula (<https://sciprofiles.com/profile/665784>)

Website (<http://www.materials.uoi.gr/en/barkoula.php>)

Section Board Member

Department of Materials Science and Engineering, University of Ioannina, 45110 Ioannina, Greece

Interests: structure-property relationships in materials; durability of polymers/polymer composites and cement-based composites; tribological behavior of polymers; metals and composites; biodegradable/biobased polymers; recyclability; eco-composites, nanocomposites/multi-functional materials/hierarchical composites




Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Zbigniew Bartczak (<https://sciprofiles.com/profile/388232>)

MDPI
Website (<https://www.cbmm.lodz.pl/>)

Section Board Member

Centre of Molecular and Macromolecular Studies, Polish Academy of Sciences, Division of Polymers, Sienkiewicza 112, 90-363 Lodz, Poland   

Interests: structure and properties of crystalline polymers; plastic deformation and orientation of polymeric materials; polymer blends and composites; crystallization of polymers nanocompounds



Dr. Matthias Barz (<https://sciprofiles.com/profile/213434>)

Website (<https://barzlab.com/dr-rer-nat-matthias-barz/>)

Section Board Member

Institute of Organic Chemistry, Johannes Gutenberg-Universität Mainz, Mainz, Germany

Interests: Polypeptides; polypeptoids; polypept(o)ides; nanomedicine; in vivo click chemistry; disulfide chemistry; secondary structure directed solution self-assembly



Prof. Dr. Giuseppe Battaglia (<https://sciprofiles.com/profile/853061>)

Website (<https://www.molecularbionics.org>)

Section Board Member

Department of Chemistry, Department of Chemical Engineering, Institute of Physics of Living System, University College London, London, UK

Interests: nanomedicine; drug delivery; physical biology; active matter; self assembly; vesicles; biodegradable and biocompatible polymers; transmission electron microscopy



Prof. Dr. Emin Bayraktar (<https://sciprofiles.com/profile/409365>)

Website (<http://lisma.supmeca.fr/?q=node/4472>)

Section Board Member

School of Mechanical and Manufacturing Engineering, Supmeca-Paris, 3 rue Fernand Hainaut, 93400 Saint Ouen, France

Interests: advanced manufacturing processes (sinter forging, thixoforming); damage mechanisms of materials (metallic, intermetallic, rubber and epoxy-based composites); design of new composites and damage characterization; design and manufacturing of recycled constituent composites

Special Issues, Collections and Topics in MDPI journals



Dr. Emiliano Bedini (<https://sciprofiles.com/profile/270315>)

Website (https://www.researchgate.net/profile/Emiliano_Bedini)

Section Board Member

Department of Chemical Sciences, Università degli Studi di Napoli Federico II, Complesso Universitario Monte S. Angelo, via Cintia 4, I-80126 Napoli, Italy

Interests: semi-synthetic polysaccharides; sulfated polysaccharides; NMR of polysaccharides; protecting groups in polysaccharide chemistry

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Mario Beiner (<https://sciprofiles.com/profile/1405696>)

Website1 (<https://www.imws.fraunhofer.de/de/presse/news/Fraunhofer-PAZ-am-Chemiestandort-Schkopau.html>) **Website2** (https://www.chemie.uni-halle.de/bereiche_der_chemie/technische_chemie/ak_weidisch/mitarbeiter/mariobeiner/?lang=de)

Section Board Member

1. Fraunhofer Institute for Microstructure of Materials and Systems IMWS, D-06120 Halle, Germany

2. Naturwissenschaftliche Fakultät II, Martin-Luther-Universität Halle-Wittenberg, D-06120 Halle, Germany

Interests: polymer dynamics; glass transition; polymer crystallization; micro- and nanophase separation in polymers; rubber composites



Dr. Ana Beltrán Sanahuja (<https://sciprofiles.com/profile/239863>)

Website (https://www.researchgate.net/profile/A_Sanahuja)

Section Board Member

Analytical Chemistry, Nutrition & Food Sciences Dept., University of Alicante, 03690 Alicante, Spain

Interests: active food packaging; polymers characterization; analytical chemistry; food chemistry; food authentication, food waste reduction, polyphenols; volatile composition; antioxidant activity; oxidative stability of foods

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Sidi A. Bencherif (<https://sciprofiles.com/profile/233397>)

Website (<https://coe.northeastern.edu/people/bencherif-sidi/>)

Section Board Member

Department of Chemical Engineering, Northeastern University, Boston, MA 02115, USA

Interests: biomaterials; cryogels; drug delivery; tissue engineering; cancer immunotherapy

Special Issues, Collections and Topics in MDPI journals



Dr. Maria Bercea (<https://sciprofiles.com/profile/1152050>)

Website (<https://mariabercea.wordpress.com/>)

Section Board Member

"Petru Poni" Institute of Macromolecular Chemistry of Romanian Academy, 41 A, Grigore Ghica Voda Alley, 700487 Iasi, Romania

Interests: thermodynamic and rheological approaches for polymer-containing systems; conformational characteristics of polymers in solution; viscoelastic behavior of macromolecules in different flow conditions; soft materials—solutions, suspensions, hydrogels; stimuli-responsive (bio)materials; porous membranes; self-assembling phenomena

Special Issues, Collections and Topics in MDPI journals



Dr. Paola Bernardo (<https://sciprofiles.com/profile/479041>)

Website (https://www.researchgate.net/profile/Paola_Bernardo)

Section Board Member

Institute on Membrane Technology, ITM-CNR (c/o University of Calabria), Via P. Bucci 17/C, 87036 Rende (CS), Italy

Interests: study of the transport properties of gas and vapours in nanocomposite and nanostructured membranes; preparation and characterization of dense, asymmetric and composite polymeric membranes for gas separation, as flat sheets or hollow fibers.; structure-Property Correlations and macroscopic modeling for nanocomposite membranes;



Prof. Dr. Filippo Berto (<https://sciprofiles.com/profile/281379>)

Website (<http://dicma.ing.uniroma1.it/node/6127>)

Section Board Member

Renowned Chair and Distinguished Professor of Mechanics of Materials, Sapienza University of Rome, 00185 Rome, Italy

Interests: mechanics of materials; fatigue; fracture; mechanics; structural integrity; materials science & engineering

Special Issues, Collections and Topics in MDPI journals



Dr. Somen K. Bhudolia (<https://sciprofiles.com/profile/231275>)

Website (https://www.researchgate.net/profile/Somen_Bhudolia)

Section Board Member

Materials Scientist (Sr)-Non-Metallics, Materials Science Lab, Halliburton Completion Tools, 11 Tuas South Avenue 12, Singapore 637131, Singapore

Interests: thermoplastic composites; out of autoclave processes; non crimp fabrics; thin ply composites; microwave curing; fusion joining of thermoplastic composites; automation and mass production of composite structures; aerospace structures; acrylic E-lum-based composites

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Markus Biesalski (<https://sciprofiles.com/profile/1140103>)

Website (https://www.chemie.tu-darmstadt.de/map/index/map_group_main/people/prof_dr_biesalski/profdrbiesalski.en.jsp)

Section Board Member

Macromolecular and Paper Chemistry, Technical University of Darmstadt, Alarich-Weiss-Straße 8, 64287 Darmstadt, Germany

Interests: paper chemistry & functional paper materials paper microfluidics; advanced diagnostics with paper; functional biopolymers; cellulose materials; lignin materials; surface modification using polymer thin films; wetting phenomena on polymeric surfaces

Special Issues, Collections and Topics in MDPI journals



Dr. Emiliano Bilotti (<https://sciprofiles.com/profile/1101421>)

Website (<https://www.imperial.ac.uk/people/e.bilotti>)

Section Board Member

School of Engineering and Materials Science, Queen Mary University of London, Mile End Road, London E1 4NS, UK

Interests: polymer nanocomposites; pyro-resistive polymer composites; organic thermoelectrics; piezo-electric polymers; high performance fibres



Prof. Dr. Ignazio Bianco (<https://sciprofiles.com/profile/451952>)

Website (<http://www.dmfc.unict.it/users/ibianco/>)

Section Board Member

Department of Civil Engineering and Architecture, University of Catania, Viale A. Doria 6, 95125 Catania, Italy

Interests: materials; polymers; thermal properties; nanocomposites; composites

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Andrzej Bledzki (<https://sciprofiles.com/profile/1325036>)

Website (<http://ztp.zut.edu.pl/index.php?id=6204>)

Section Board Member

Faculty of Mechanical Engineering and Mechatronics, West Pomeranian University of Technology in Szczecin, 70-310 Szczecin, Poland

Interests: thermoplastic and duroplastic biocomposites; self-reinforced composites; recycling, processing of thermoplastics and duroplastics



Prof. Dr. Anton Blencowe (<https://sciprofiles.com/profile/374125>)

Website (<https://people.unisa.edu.au/Anton.Blencowe>)

Section Board Member

Applied Chemistry and Translational Biomaterials (ACTB) Group, Clinical and Health Sciences, University of South Australia, Adelaide, SA 5001, Australia

Interests: chemistry; biomaterials; bioconjugates; peptides; drug delivery; hydrogels



Prof. Dr. Joshua Boateng (<https://sciprofiles.com/profile/123669>)

Website (<http://www2.gre.ac.uk/about/schools/science/about/departments/pces/staff/dr-joshua-boateng>)

Section Board Member

Pharmaceutics and Drug Delivery, School of Science, Faculty of Engineering and Science, University of Greenwich, Medway Campus, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK

Interests: pharmaceutical and formulation sciences; advanced wound healing technologies; mucosal drug delivery systems

Special Issues, Collections and Topics in MDPI journals



Dr. Patrycja Bober (<https://sciprofiles.com/profile/633650>)

Website (<https://www.imc.cas.cz/en/umch/index.htm>)

Section Board Member

Department of Conducting Polymers, Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic, 16206 Prague, Czech Republic

Interests: conducting polymers; composites; sensors; energy storage and conversion

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Pedro G. Boj

Website (<https://cvnet.cpd.ua.es/curriculum-breve/es/boj-gimenez-pedro-jose/17856>)



Dr. Anna Borriello (<https://sciprofiles.com/profile/589910>)

Website (https://www.researchgate.net/profile/Anna_Borriello2)

Section Board Member

IPCB - Institute of Polymers, Composites and Biomaterials, CNR –National Research Council of Italy - UOS Napoli/Portici-National Research Council, Portici, Italy

Interests: design, synthesis, study of proprieties, and engineering of polymeric systems. current emphases include: electrically conductive polymers; nanofillers in polymer composite polymer electrolyte membranes; bio-inspired materials

Special Issues, Collections and Topics in MDPI journals



Dr. Ranjita K. Bose (<https://sciprofiles.com/profile/589090>)

Website (<https://www.rug.nl/staff/r.k.bose/research>)

Section Board Member

Engineering and Technology institute Groningen (ENTEG), University of Groningen, Nijenborgh 4, 9747AG Groningen, The Netherlands

Interests: self-healing; supramolecular polymers; iCVD; thin films

Special Issues, Collections and Topics in MDPI journals



Dr. Ioan Botiz (<https://sciprofiles.com/profile/66779>)

Website (<https://nanobiophotonics.ro/member/ioan-botiz-117>)

Section Board Member

Interdisciplinary Research Institute in Bio-Nano-Sciences of the Babes-Bolyai University, Cluj-Napoca, Romania

Interests: processing of (conjugated) polymers; structure-optoelectronic properties relationship; polymeric nanostructures; hierarchical architectures; (reduced) graphene oxide-polymer composites; morphology investigations by AFM



Prof. Dr. Luigi Botta (<https://sciprofiles.com/profile/166640>)

Website (<https://www.unipa.it/persona/docenti/b/luigi.botta>)

Section Board Member

Department of Engineering, RU INSTM of Palermo, University of Palermo, Viale delle Scienze ed.6, 90128 Palermo, Italy

Interests: polymer composites and nanocomposites; polymer blends; bioplastics; rheology; degradation and stabilization of polymer systems; antimicrobial polymeric systems

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Serge Bourbigot (<https://sciprofiles.com/profile/258514>)

Website (<http://umet.univ-lille1.fr/detailscomplets.php?id=46&lang=en>)

Section Board Member

Unité Matériaux et Transformations (UMET), University of Lille, CNRS, ENSCL, Villeneuve-d'Ascq, France

Interests: reaction and resistance to fire of polymeric materials; polymer processing; solid state NMR of polymer; pyrolysis; heat transfer; modeling and numerical simulation of decomposing polymers

Prof. Dr. Pierangiola Bracco (<https://sciprofiles.com/profile/284540>)

Website (https://www.chimica.unito.it/do/docenti.pl/Show?_id=pabracco)

Section Board Member

Department of Chemistry, University of Torino, Via Pietro Giuria 7, 10125 Torino, Italy

Interests: biomedical polymers; polymer degradation and stabilization; electrospinning; polymer characterization, polymer irradiation

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Wim Briels

Website (<http://cbp.tnw.utwente.nl/People/briels.html>)

Section Board Member

1. Computational Chemical Physics, Faculty of Science and Technology, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

2. MESA+ Institute for Nanotechnology, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

3. Forschungszentrum Jülich, ICS-3, D-52425 Jülich, Germany

Interests: computer simulations of condensed matter



Prof. Dr. Nicolas Brosse (<https://sciprofiles.com/profile/166951>)

Website (<http://lrmab.univ-lorraine.fr/membres/brosse-nicolas>)

Section Board Member

Laboratoire d'Etudes et de Recherche sur le Matériau Bois, Faculté des Sciences et Technologies, Université de Lorraine, EA 4370, Boulevard des Aiguillettes, BP 70239, 54506 Vandœuvre-Lès-Nancy CEDEX, France

Interests: wood chemistry; wood waste recycling; pretreatment; steam explosion

Special Issues, Collections and Topics in MDPI journals

Prof. Dr. Marek Bryjak (<https://sciprofiles.com/profile/2252727>)

Website (<https://wch.pwr.edu.pl/en/employees/marek-bryjak>)

Section Board Member

Department of Process Engineering and Technology of Polymer and Carbon Materials, Faculty of Chemistry, Wrocław University of Science and Technology, Norwida 4/6, 50-373 Wrocław, Poland

Interests: functional polymers; polymer membranes; separation processes; polymer modification; surface characterization



Dr. Alexey Bubnov (<https://sciprofiles.com/profile/480634>)

Website (<https://www.fzu.cz/bubnov>)

Section Board Member

Institute of Physics of the Czech Academy of Sciences Na Slovance 1999/2, 18221 Prague, Czech Republic

Interests: low molar mass liquid crystals; macromolecular liquid crystals; reactive mesogens; self-organization; soft nano-composite systems; ferroelectric liquid crystals;

Prof. Dr. Michael R. Buchmeiser (<https://sciprofiles.com/profile/3226>)

Website (<https://www.ipoc.uni-stuttgart.de/msf/>)

Section Board Member

Chair of Macromolecular Compounds and Fiber Chemistry, Institute of Polymer Chemistry, University of Stuttgart, D-70569 Stuttgart, Germany

Interests: catalytic polymerization; chemical and physical surface modification; porous polymeric supports and their use in heterogeneous catalysis; fiber chemistry including high-performance carbon; polymeric and inorganic fibers

Special Issues, Collections and Topics in MDPI journals



Dr. Biljana Bujanovic (<https://sciprofiles.com/profile/2531339>)

Website1 (<https://www.fs.usda.gov/research/about/people/biljana.bujanovic>) **Website2** (<https://www.esf.edu/faculty/bujanovic/>)

Section Board Member

USDA-FS-Forest Products Laboratory, Madison, WI, USA

Interests: chemical composition of wood; lignin; delignification; biorefineries; lignin valorization

Special Issues, Collections and Topics in MDPI journals



Dr. Rafael Delgado Buscalioni

Website (<https://dep.ftmc.uam.es/members/name/rafael-delgado-buscalioni/>)

Section Board Member

Department of Theoretical Condensed Matter Physics, Universidad Autónoma de Madrid, Campus de Cantoblanco, 28049 Madrid, Spain

Interests: polymer dynamics in solution or melt; coarse grained models



Prof. Dr. James Busfield (<https://sciprofiles.com/profile/485573>)

Website (<https://www.sems.qmul.ac.uk/staff/j.busfield>)

Section Board Member

School of Engineering and Materials Science, Queen Mary University of London, Mile End Road, London E1 4NS, UK

Interests: rubber physics; modelling of elastomers; filler reinforcement; nano-composites; tyre design; rubber abrasion & friction; rubber fracture and fatigue; viscoelastic behaviour; dielectric elastomer actua



Dr. Uģis Cābulis

Website (<http://www.kki.lv/en/user/235>)

Section Board Member

Polymer Laboratory, Latvian State Institute of Wood Chemistry, 27 Dzerbenes St., LV-1006 Riga, Latvia

Interests: polyurthane science and technology; polymers from renewable resources; thermal and cryogenic insulation

Special Issues, Collections and Topics in MDPI journals



Dr. Gregorio Cadenas-Pliego (<https://sciprofiles.com/profile/375571>)

Website (<https://scholar.google.com/citations?user=s9q6PIMAAAAJ&hl=es&authuser=1>)

Section Board Member

Department of Nanomaterials Chemistry, Centro de Investigación en Química Aplicada, Satlillo 25294, Mexico

Interests: synthesis of metallic nanoparticles; synthesis of nanoparticle–polymer composites; surface modification of nanoparticles; electrically conductive polymer composites; thermal conductive polymer composites; antimicrobial polymers; photocatalyst/polymer composites; polymer–carbon composites; polymer composites for water treatment

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Jie Cai (<https://sciprofiles.com/profile/2661142>)

Website (<http://jszy.whu.edu.cn/caijie1/en/index.htm>)

Section Board Member

School of Chemistry and Molecular Science, Wuhan University, Wuhan, China

Interests: cellulose; chitosan; chitin; polymer physics; natural polymer; environmentally friendly materials; biomedical materials



Dr. Sylvain Caillol (<https://sciprofiles.com/profile/223177>)

Website (<https://www.icgm.fr/Sylvain-Caillol/>)

Section Board Member

Institut Charles Gerhardt Montpellier (ICGM), University of Montpellier, CNRS, ENSCM, 34095 Montpellier, France

Interests: green and sustainable chemistry; building-blocks from biomass; biobased monomers and polymers

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Marcelo Calderón (<https://sciprofiles.com/profile/899824>)

Website (<http://www.polymat.eu/en/people/senior-researchers/marcelo-calderon>)

Section Board Member

Polymat, Basque Center for Macromolecular Design and Engineering, Paseo Manuel de Lardizabal 3, 20018 Donostia-San Sebastian, Spain

Interests: biocompatible FRET-based imaging systems; multifunctional polymer-drug conjugates; environmentally responsive nanogel synthesis; self-assembling amphiphiles for controlled delivery of genes

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Cesare Cametti (<https://sciprofiles.com/profile/60603>)

Website1 (https://www.researchgate.net/profile/Cesare_Cametti) **Website2** (<https://www.scopus.com/authid/detail.uri?authorid=56247959600>)



Prof. Dr. Andres Cantarero (<https://sciprofiles.com/profile/78933>)

Website (https://www.researchgate.net/profile/Andres_Cantarero)

Section Board Member

Institute for Molecular Science (ICMol), University of Valencia, Valencia, Spain

Interests: thermoelectric properties; polymer; organic 2D materials



Dr. Moyuan Cao (<https://sciprofiles.com/profile/2213199>)

Website (https://mse.nankai.edu.cn/cmy_en/list.htm)

Section Board Member

School of Chemical Engineering and Technology, Tianjin University, Tianjin 300350, China

Interests: superhydrophobic; interface; fluid manipulation; bioinspired materials; asymmetric surface; superwettability



Dr. Alessandra Carbone (<https://sciprofiles.com/profile/931355>)

Website (<http://www.itae.cnr.it/en/staff/carbone-alessandra/>)

Section Board Member

CNR Institute for Advanced Energy Technologies "Nicola Giordano", ITAE, Messina, Italy

Interests: polymers; functional groups; composites; ion conductivity; fuel cells; polymer electrolytes; anionic membranes; protonic membranes; alkaline electrolyzers; PEFC; AMFC

Special Issues, Collections and Topics in MDPI journals



Dr. Federico Carosio (<https://sciprofiles.com/profile/360468>)

Website (https://didattica.polito.it/portal/pls/portal/sviluppo.scheda_pers_swias.show?m=016599)

Section Board Member

Dipartimento di Scienza Applicata e Tecnologia, Politecnico di Torino-Alessandria Campus, 15121 Alessandria, Italy

Interests: nanostructured coatings; layer-by-layer assembly; polymer composites; polymer nanocomposites; nanocellulose-based materials; graphene related materials; flame retardancy; gas barrier properties

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Mauro Carraro (<https://sciprofiles.com/profile/73965>)

Website (<http://www.chimica.unipd.it/mauro.carraro/>)

Section Board Member

Department of Chemical Sciences, University of Padova, Padua, Italy

Interests: hybrid polymeric membranes for water treatment; hybrid copolymers; catalytic polymers

Special Issues, Collections and Topics in MDPI journals



Dr. Sabrina Carola Carroccio (<https://sciprofiles.com/profile/144547>)

Website (<https://www.imm.cnr.it/users/sc-carroccio>)

Section Board Member

CNR-IPCB, Via Paolo Gaifami 18, 95126 Catania, Italy

Interests: polymer mass spectrometry; hybrid polymeric materials; polymeric nanocomposites; polymer degradation

Special Issues, Collections and Topics in MDPI journals



Dr. Mariolino Carta (<https://sciprofiles.com/profile/428174>)

Website (<https://mariolino-carta.com/>)

Section Board Member

Department of Chemistry, Swansea University, Singleton Park, Swansea SA2 8PP, UK

Interests: organic chemistry; material chemistry; polymers of intrinsic microporosity; gas separation

Special Issues, Collections and Topics in MDPI journals



Dr. Nerea Casado

Website (<https://publons.com/researcher/4097131/nerea-casado>)

Section Board Member

Joxe Mari Kortza Center, POLYMAT University of the Basque Country UPV/EHU, 20018 Donostia-San Sebastian, Spain

Interests: conducting polymers; redox polymers; mixed ionic-electronic conductors; organic ionic plastic crystals; energy storage



Prof. Dr. Walter Remo Caseri (<https://sciprofiles.com/profile/10914>)

Website (<https://multimat.mat.ethz.ch/people/caseriw.html>)

Section Board Member

Department of Materials, ETH Zürich, HCI F 515, Vladimir-Prelog-Weg 5, CH-8093 Zürich, Switzerland

Interests: inorganic polymers; organometallic polymers; nanocomposites

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Sergio Caserta (<https://sciprofiles.com/profile/612796>)

MDPI
Website (<https://www.docenti.unina.it/sergio.caserta>)

Section Board Member

Department of Chemical, Università degli Studi di Napoli Federico II, Naples, Italy

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Interests: chemical engineering; transport phenomena; thermodynamics; rheology; rheo-optic; non-newtonian fluids; multiphase fluids; flow induced morphology; droplets; coalescence; polymer blends; diffusion; dissolution; motion tracing; microfluidics; interfacial engineering; surfactants; wetting; image analysis; microscopy; shear banding; biomedical engineering; biotechnologies; biofilm; cancer growth; cell motility



Dr. Alfredo Cassano (<https://sciprofiles.com/profile/80600>)

Website (<https://www.itm.cnr.it/index.php/en/alfredo-cassano-en>)

Section Board Member

Institute on Membrane Technology, ITM-CNR, 87036 Rende, Italy

Interests: membranes and integrated membrane operations in agro-food production; pressure-driven membrane operations; membrane distillation and osmotic distillation; membrane fouling; food processing; food science and technology; bioactive compounds; phenolic compounds; proteins; peptides; agri-food by-products valorization; circular economy

Special Issues, Collections and Topics in MDPI journals



Dr. Rachele Castaldo (<https://sciprofiles.com/profile/334242>)

Website (<https://scholar.google.it/citations?hl=it&user=DRIJ3asAAAAJ>)

Section Board Member

Institute for Polymers, Composites and Biomaterials of the National Research Council of Italy (IPCB-CNR), via Campi Flegrei 34, 80078 Pozzuoli, Italy

Interests: microporous polymers; high surface area nanocomposites; nanostructured materials; biobased polymers

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Gennara Cavallaro (<https://sciprofiles.com/profile/292864>)

Website (<http://www.unipa.it/persone/docenti/c/gennara.cavallaro/?pagina=ricerca>)

Section Board Member

Department of Science and Technology, Biological, Chemical and Pharmaceutical, University of Palermo, 32-90123 Palermo, Italy

Interests: functionalization of polymers for biomedical application; nanotechnologies for drug delivery; colloidal drug delivery systems; microparticles; nanoparticles; macromolecular prodrugs; polymeric micelles; polymeric micro- and nanoparticles for different administration routes including parenteral and pulmonary administration; polymeric vector for gene therapy



Prof. Dr. Dario Cavallo

Website (<http://www.chimica.unige.it/rubrica/138>)

Section Board Member

Department of Chemistry and Industrial Chemistry, University of Genoa, Via Dodecaneso 31, 16146 Genova, Italy

Interests: structuring processes of semicrystalline polymers

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Carlo Cavallotti (<https://sciprofiles.com/profile/12063>)

Website (<https://www.cmic.polimi.it/en/persone/docenti-e-ricercatori/cavallotti-carlo-alessandro/>)

Section Board Member

Politecnico di Milano, Department of Chemistry, Materials and Chemical Engineering, via Mancinelli 7, 20131 Milano, Italy

Interests: polymerization kinetics; ab initio and DFT estimation of rate constants; KMC simulation of reactive systems; molecular dynamics; bioseparation materials; polymer-protein interactions

Special Issues, Collections and Topics in MDPI journals



Prof. Dr. Joan Josep Cerdà

Website (<https://www.uib.eu/personal/ABTE1NDA3/>)

Section Board Member

Department of Physics UIB and Institute of Computational Applications of Community Code (IAC3), University of the Balearic Islands, E-07122 Palma de Mallorca, Spain

Interests: polymer simulations; polymer physics; polymer applications; magnetic polymers; polymer nanocomposites; biopolymers; physics of polymers and colloids



Prof. Dr. Thiago Regis Longo Cesar Paixão (<https://sciprofiles.com/profile/90451>)

Website (http://www3.iq.usp.br/pessoas_view.php?idDocente=405)

Section Board Member

Institute of Chemistry, The University of São Paulo, 748 Prof. Lineu Prestes Av., São Paulo 05508-000, Brazil

Interests: chemical sensing; modified electrodes; paper-based devices; electronic tongues and point-of-need application for sensing

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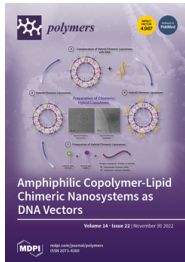
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



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
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Height-to-Diameter Ratio and Porosity Strongly Influence Bulk Compressive Mechanical Properties of 3D-Printed Polymer Scaffolds (I2073-4360/14/22/5017)

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Polymers 2022, 14(22), 4988; <https://doi.org/10.3390/polym14224988> (<https://doi.org/10.3390/polym14224988>) - 17 Nov 2022

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Synthesis of Biobased Hydroxyl-Terminated Oligomers by Metathesis Degradation of Industrial Rubbers SBS and PBT and Maleic-Unsaturated Diols and Polyols ([/2073-4360/14/22/4973](#))

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Polymers **2022**, 14(22), 4923; <https://doi.org/10.3390/polym14224923> (<https://doi.org/10.3390/polym14224923>) - 15 Nov 2022

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Self-Healing and Reprocessable Oleic Acid-Based Elastomer with Dynamic S-S Bonds as Solvent-Free Reusable Adhesive on Copper Surface (I2073-4360/14/22/4919)

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Development of an Atmospheric Pressure Plasma Jet Device Using Four-Bore Tubing and Its Applications of In-Liquid Material Decomposition and Solution Plasma Polymerization (I2073-4360/14/22/4917)

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Fabrication and Characterization of Intelligent Multi-Layered Biopolymer Film Incorporated with pH-Sensitive Red Cabbage Extract to Indicate Fish Freshness (I2073-4360/14/22/4914)

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
















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Effect of Piezoelectric BaTiO₃ Filler on Mechanical and Magnetolectric Properties of Zn_{0.25}Co_{0.75}Fe₂O₄/PVDF-TrFE Composites (2073-4360/14/22/4807)

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Polymers 2022, 14(22), 4803; <https://doi.org/10.3390/polym14224803> (<https://doi.org/10.3390/polym14224803>) - 08 Nov 2022

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Polymers 2022, 14(22), 4802; <https://doi.org/10.3390/polym14224802> (<https://doi.org/10.3390/polym14224802>) - 08 Nov 2022

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Effect of Kaolin Clay and ZnO-Nanoparticles on the Radiation Shielding Properties of Epoxy Resin Composites (2073-4360/14/22/4801)

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Preparation and Characterization of Polyanhydride Terminated with Oleic Acid Extracted from Olive Mills Waste (2073-4360/14/22/4799)

Polymers 2022, 14(22), 4799; <https://doi.org/10.3390/polym14224799> (<https://doi.org/10.3390/polym14224799>) - 08 Nov 2022

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Polymers 2022, 14(22), 4795; <https://doi.org/10.3390/polym14224795> (<https://doi.org/10.3390/polym14224795>) - 08 Nov 2022

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Article

Acceleration of Bone Fracture Healing through the Use of Bovine Hydroxyapatite or Calcium Lactate Oral and Implant Bovine Hydroxyapatite–Gelatin on Bone Defect Animal Model

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Abstract: Bone grafts a commonly used therapeutic technique for the reconstruction and facilitation of bone regeneration due to fractures. BHA–GEL (bovine hydroxyapatite–gelatin) pellet implants have been shown to be able accelerate the process of bone repair by looking at the percentage of new bone, and the contact between the composite and bone. Based on these results, a study was conducted by placing BHA–GEL (9:1) pellet implants in rabbit femoral bone defects, accompanied by 500 mg oral supplement of BHA or calcium lactate to determine the effectiveness of addition supplements. The research model used was a burr hole defect model with a diameter of 4.2 mm in the cortical part of the rabbit femur. On the 7th, 14th and 28th days after treatment, a total of 48 New Zealand rabbits were divided into four groups, namely defect (control), implant, implant + oral BHA, and implant + oral calcium lactate. Animal tests were terminated and evaluated based on X-ray radiology results, *Hematoxylin-Eosin* staining, vascular endothelial growth Factor (VEGF), osteocalcin, and enzyme-linked immunosorbent assay (ELISA) for bone alkaline phosphatase (BALP) and calcium levels. From this research can be concluded that Oral BHA supplementation with BHA–GEL pellet implants showed faster healing of bone defects compared to oral calcium lactate with BHA–GEL pellet implants.

Keywords: defect; bone remodeling; bovine hydroxyapatite; calcium lactate; BHA–GEL pellet

1. Introduction

Bone is a special connective tissue that hardens via the process of mineralization by calcium phosphate in the form of hydroxyapatite [1]. Various kinds of bone, joint, and muscle diseases in humans include open fractures, closed fractures, osteoporosis, osteoarthritis, osteomalacia, osteomyelitis, rheumatic polymyalgia, gouty arthritis, rheumatoid arthritis and others, with fractures being the most common large organ traumatic injury in humans [2]. A fracture is neuromuscular damage due to trauma to the tissue [3] and results in a gap in the bone. Fracture repair can generally restore damaged skeletal organs to their preinjury cellular composition, structure, and biomechanical function, but about 10% of fractures will not heal normally [2]. In 2011, the World Health Organization (WHO) recorded more than 1.3 million people suffering from fractures due to accidents. Accident cases that have a fairly high prevalence, amongst which are lower extremity fractures, represent 40% of the accidents that occur. Bone graft therapy, with a surgical procedure that places new bone or replacement material (composite matrix) into the space around the fracture or hole in the damaged bone (defect) to help speed up the healing process [3], is commonly used in fracture management [4].

Bovine hydroxyapatite (BHA) is an inorganic bovine bone material used as an alternative composite component, consisting of 93% hydroxyapatite ($\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$) and 7% β -tricalcium phosphate ($\text{Ca}_3(\text{PO}_4)_2$). As a result, it is more porous and can only absorb antibiotics, hormones or growth factors [5]. BHA has properties similar to hydroxyapatite in human bone and is a scaffold that is more osteoconductive than other synthetic hydroxyapatites, is biocompatible and has high porosity. The high porosity of BHA accelerates the process of colonization of osteoblast cells and becomes a medium for osteoblast cells to stick to [6]. On the other hand, BHA is brittle as a new bone-forming material, so gelatin is added as an adhesive and smoothing agent [5]. Gelatin (GEL) is a macromolecule produced by partial hydrolysis of collagen from skin, white connective tissue and animal bones of amino acid residues [7]. GEL is commonly called type one collagen which together with osteoblasts forms osteoids (soft callus). BHA–GEL composites that resemble mineral components in humans are able to form new bone and fill bone gaps due to fractures [5] with high biocompatible properties, osteoconductive, osteoinductive, biodegradable, bioresorbable, and non-toxic [8,9]. The addition of gelatin can also control the degradation of pellet time and increase the synthesis of new bone in the defect area [10].

BHA–GEL composite implants have been shown to be able to accelerate the bone repair process in fractured rabbit femurs within 28 to 42 days, and have good biomaterials for bone filling [11]. However, this period of time is still relatively long when considering the effect of pain felt by patients with fractured bones, and can affect the patient's psychological (anxiety) level [12]. Repair of bone mineralization alone is not sufficient to meet demand and can affect skeletons with inadequate bone tissue function. It is necessary to increase the supply of calcium. Simple calcium preparations are generally administered orally as an adjuvant to treatment, in combination with more specific drugs [13]. For this reason, a study was carried out on bone defects due to fractures with BHA–GEL pellet implants and the addition of BHA or calcium lactate orally as calcium supplements. Calcium intake plays an important role in maintaining bone health, namely to achieve peak bone mass and prevent loss of bone mass [14]. The purpose of supplementation in this study was to prove that the period of bone growth around the defect could be shortened. Osteoblast proliferation is expected to increase with the addition of oral BHA supplements to form more osteoids (soft callus), which are then converted into osteocytes (hard callus) and can increase bone stability around the fracture.

BHA is known to have carbonate substitutions like that of human hydroxyapatite and that can be found in synthetic biomimetic hydroxyapatites [15,16]. The carbonate group increases the proliferation of osteoblasts, thereby accelerating the formation of new bone [17]. Hydroxyapatite raises blood calcium levels less than calcium carbonate and calcium citrate. This indicates that hydroxyapatite is more effective at entering bone cells [18]. BHA bioavailability is better than calcium carbonate [14] and absorbed about 42.5% [19]. A European study showed that hydroxyapatite was more effective than calcium carbonate in slowing bone loss of the peripheral trabeculae of the distal tibia and distal radius [14]. The role of oral BHA is to increase the proliferation of osteoblasts by stimulating mesenchymal cells. It is shown by the calcium deposition from hydroxyapatite will interact with the collagen fibers along with type I collagen, a substance from the degradation of gelatin. During the mineralization process, the ends of the bone fragments are covered by a fusiform mass filled with woven bone. The more minerals deposited, the harder the callus formed [20]. While calcium lactate which is a salt form of lactic acid in the form of white powder, crystals or grains [21], which is also given orally because it can increase the number of osteoblasts [22]. Calcium lactate intake can increase extracellular calcium and intracellular calcium levels, stimulating bone formation significantly and increasing the proliferation or chemotaxis of osteoblasts [22]. Calcium lactate also significantly reduces bone resorption [23]. In addition, calcium lactate in the body is easily converted into calcium bicarbonate, and only about 25% is absorbed in the small intestine from calcium intake through passive diffusion and active transport [24]. A study shows a comparison of 500 mg calcium lactate, 500 mg carbonate and 500 mg gluconate (it is known that each

calcium content is different), the results of which show the absorption, AUC and excretion of calcium lactate to be better than others [25]. Calcium lactate absorption is better than calcium phosphate and calcium in milk, and stimulates bone activity more than calcium carbonate or calcium citrate in experimental rats. As a consequence, it is very effective, especially in bone metabolism [22]. However, based on the research of previous results, it is known that BHA has more osteoinductive properties than other materials do not have [26]. For this reason, it is possible that oral administration of BHA on BHA–GEL pellet implants is more effective in terms of bone growth than oral administration of calcium lactate on BHA–GEL pellet implants.

2. Materials and Methods

2.1. Ethical Approval

The submission of an ethical feasibility proposal was addressed to the Research Ethics Commission of the Faculty of Veterinary Medicine, Universitas Airlangga (Animal Care and Use Committee/ACUC) and has been declared ethically eligible via Ethical Clearance No. 2.KEH.075.05.2022.

The research was conducted in the laboratory of the Faculty of Pharmacy, Universitas Airlangga, Surabaya in a true experimental manner with a posttest-only control group study design using 48 New Zealand rabbits aged 4–8 months, weighing 1.5–2.5 kg, healthy and without bone disorders in femur. The rabbits were randomly divided into defect (control groups), BHA–GEL pellet implant group, BHA–GEL pellet implant group with oral BHA and BHA–GEL pellet implant group with oral calcium lactate. Rabbits were adapted for one week with adequate food provided during the study. Making a rabbit fracture model was made by generating a defect in the femur, followed by implanting a BHA–GEL pellet implant according to the group division. Furthermore, oral supplements of BHA or calcium lactate were administered until termination was carried out on days 7, 14 and 28, according to group division. After termination, the femur bone that was treated as a sample was taken; this was followed by evaluation through X-ray radiology, and then bone decalcification, to evaluate the number and distribution of bone cells through HE (*Hematoxylin-Eosin*) staining, evaluation of anti-vascular endothelial growth factor (VEGF) and osteocalcin levels using the immunohistochemical (IHC) method.

2.2. Materials

In terms of test materials, bovine hydroxyapatite (Universitas Airlangga, Indonesia), gelatin, sodium carboxymethyl cellulose powder, aquadest, ketamine, xylazine, gentamicin ointment, ampicillin, 70% alcohol (pharmaceutical grade), cotton balls, povidone iodine, savlon, cotton bud, sterile gauze, hypafix, handsplast, calcium lactate 500 mg tablet, thrombophob gel, water for injection, 10% formalin buffer, and a Calcium Colorimetric Assay Kit, ELISA Kit (Cat No. MAK022) (Sigma-aldrich, St. Louis, MO, USA) were acquired. In terms of equipment, a Carver manual pellet press, punch and die (4 mm diameter), 1 cc and 3 cc syringe, bone drill with 4.2 mm drill bit, surgical blade, forceps, needle holder, needle circle or surgical needles, Silk no.3 surgical thread, gillette razor, shaver, tweezers, scissors, leukoplast, vacutainer gel separator, water bath, mortar, stamper, granule sieve, oven, feeding tube, oral catheter, X-ray machine, ELISA reader, light microscope, histology slides, object glass and cover glass were used.

2.3. BHA–GEL Pellet Preparation

Weigh and put 9 g Bovine hydroxyapatite (BHA) powder into a mortar and then reduce the particle size using a stamper. Heat 6 mL of distilled water in a glass beaker at 40 °C, then add 2 g of gelatin and stir until the gelatin dissolves. Put 3 mL of dissolved gelatin into a mortar containing BHA and stir until the mass is formed. Next, sieve the mass to obtain a uniform particle size and dry in an oven at 40 °C for 24 h. Weigh the granules as large as 100 mg and compress with a load of 1 ton with a diameter of 4 mm to form BHA–GEL pellets, and continue with UV sterilization for ±3 h.

Implantation of BHA–GEL implant and oral administration of BHA or oral calcium lactate is performed by injecting a combination anesthetic ketamine 50 mg/kgBW and xylazine 5 mg/kgBW intramuscularly in experimental animals. Clean the rabbit's thighs with 70% alcohol and shave. Disinfect the shaved area using betadine then make an incision in the required area of about 1.5 cm. The defect was made using a 4.2 mm drill bit and followed by implantation of BHA–GEL pellets. Next, suture the wound, disinfect it with 70% alcohol and then betadine, and then apply gentamicin ointment as an antibiotic. Cover the wound with sterile gauze and dressing retention tape, then administer injection of Ampicillin intramuscularly at a dose of 25 mg/kgBW as an antibiotic. During the recovery period, the wound was treated with betadine and tape replacement until the surgical wound was dry. In addition, the rabbits were treated with 1 mL oral BHA or calcium lactate according to the group division.

2.4. Characterizations of Pellet

The characterization of the prepared pellets was carried out using Fourier Transform Infrared (FT-IR) Spectroscopy (Perkin Elmer, MA, USA). The BHA, Gelatin, and BHA–GELatin that have been made were then mixed with potassium bromide to make pellets and measured at a wave number of 400–4000 cm^{-1} with only one scanning, while the size and morphology of the particles were observed using scanning electron microscopy (Inspect S-50, FEI, Japan). The sputter coating of SEM used the ultra-thin coating of gold.

2.5. Blood Sampling Technique

Xylol was applied to the rabbit's ear on the marginal vein and 3 mL of blood were using a disposable syringe one hour from the time of taking the drug; this was carried out on the 7th, 14th, and 28th days before termination. Applying heparin gel to the area around the injection to prevent blood clots. Inject blood into a vacutainer containing a gel separator (serum separator tube) (OneMed, Krian, Indonesia) slowly to prevent hemolysis. Continue to centrifuge at 4000 rpm for 15 min to obtain a serum. Serum was stored in the freezer at $-80\text{ }^{\circ}\text{C}$. BALP levels were using ELISA microplate reader IMark series No. 12096 (Bio-Rad, Hercules, CA, USA), while calcium levels using a microplate reader Biochrom EZ Read 2000 serial number 135247 (Biochrom Ltd, Cambridge, United Kingdom).

2.6. Bone Sampling Technique

Termination of the experimental rabbits on the 7th, 14th and 28th days after treatment with oral drugs was performed in the instance of both BHA and calcium lactate. A bone sample of the femur in a 10% formalin was followed followed by observation of the process of closing the bone gap by X-ray radiology. Then decalcification of bone in 10% EDTA solution for observation of bone cell development through HE staining (*Hematoxylin-Eosin*), examination of VEGF and osteocalcin levels using the immunohistochemical (IHC) method.

2.7. Radiology Examination

An evaluation of bone integrity was performed using X-ray radiography and clarified with *ImageJ V1.44p*, before then compared being with the initial diameter of the bone defect (4.2 mm). This was followed by macroscopic observations to see the percentage of callus growth around the bone defect and calculations using Lane–Sandhu Scoring (Table 1).

Table 1. Lane–Sandhu Scoring Criteria [27].

Criteria	Score	Characteristics
No callus	0	no callus tissue, fracture line clear
Minimal callus	1	25% callus tissue, fracture line still clearly visible
Callus evident but healing incomplete	2	50% callus tissue, fracture line blurred
Callus evident with stability expected	3	75% callus tissue, fracture line barely visible
Complete healing with bone remodeling	4	100% callus tissue, no remaining fracture line visible

2.8. Haematoxylin and Eosin Staining

The histological examination started with processing the paraffin blocks by dehydrating with alcohol concentration 70% to 100% for 60 min each. This was followed by 3 clarifications of xylene, for 15 min each time. After that, in an incubator at 60 °C, the permeation treatment with paraffin solution was carried out three times for 60 min each. The tissue was then immersed in liquid paraffin and brought to room temperature. Each paraffin block was then cut to a thickness of 4–6 µm using a microtome. Cell morphology was determined with *hematoxylin* and *eosin*. The slides were dipped in xylene three times for 5 min each and hydrated with alcohol (96% to 70% alcohol) for 2 min each. The slides were then rinsed under running water for 10 min, placed in *Mayer's hematoxylin* for 15 min, rinsed with running water and examined microscopically. The slides were then placed in 1% eosin solution for 30 s, dried, washed, and mounted with an EZ mount. This was performed on five visual fields, with 400× magnification around the defect or implant area. The results obtained are the number of each bone cell, including osteoblasts, osteoclasts and osteocytes.

2.9. Immunohistochemistry

The immunohistochemical technique was used to stain VEGF and osteocalcin immunopositive cells. Slides that have been paraffinized are soaked with an antigen retrieval decloaking chamber, cooled for 20 min, and washed with PBS for 3 min. Sniper blocking followed for 15 min. The slides were then incubated with rabbit anti-rat VEGF primer (cat. no. PA1-21796, Thermo Fisher Scientific, 1:100 dilution) (Waltham, Massachusetts, United States) and washed in PBS for 3 min. After that, the universal link was performed for 20 min, and the slide was washed in PBS for 3 min. The Trecavidin-HRP Label was then applied for 10 min and washed with PBS for 3 min. The slides were then reacted with Chromogen DAB + Buffer Substrate for 2–5 min, followed by rinsing for 5 min with running water. The slides were then stained with *hematoxylin* for 1–2 min followed by rinsing for 5 min with running water (twice). The slides were then dehydrated with alcohol (70% absolute alcohol) for 5 min each, followed by three xylol washes for 5 min each. Finally, they were mounted on a slide (Ecomount) and covered with a cover glass.

2.10. Bone Alkaline Phosphatase

Examination of BALP levels was carried out using the Rabbit Bone-Specific Alkaline Phosphatase ELISA Kit (Cat. No. BZ-08173140-EB) (Bioenzy, Jakarta, Indonesia) with the following steps: prepare all reagents, standard solutions and samples; bring all reagents to room temperature before use. Add 50 µL standard to standard well; add 40 µL sample to sample wells and add 10 µL anti-BAP antibody to sample wells; then add 50 µL streptavidin-HRP to sample wells and standard wells (not blank control well) and mix well. Cover the plate with a sealer. Incubate for 60 min at 37 °C. After that, remove the sealer and wash the plate 5 times with a wash buffer. Soak wells with at least 0.35 mL wash buffer for 30 s to 1 min for each wash. Blot the plate onto paper towels or other absorbent material. Then, add 50 µL substrate solution A to each well and then add 50 µL substrate solution B to each well. Incubate plate covered with a new sealer for 10 min at 37 °C in the dark. Add 50 µL Stop Solution to each well, and the blue color will change into yellow immediately. Determine the optical density (OD value) of each well immediately, using a microplate reader set to 450 nm within 10 min after adding the stop solution.

2.11. Calcium Concentration

Examination of calcium levels in the blood is carried out using the Calcium Colorimetric Assay Kit (Cat. No. MAK022) (Sigma-aldrich, St. Louis, MO, USA). Serum samples can be used directly in this assay. Add 90 µL of the Chromogenic Reagent (Sigma-aldrich, St. Louis, MO, USA) to each well containing standards, samples, or controls and mix gently. Then, add 60 µL of Calcium Assay Buffer (Sigma-aldrich, St. Louis, MO, USA) to each well and mix gently. After that, incubate the reaction for 5–10 min at room temperature.

Protect the plate from light during incubation. Measure the absorbance at 575 nm (A575) before assay.

2.12. Statistical Analysis

Evaluation of the size of the bone gap that was closed radiologically was analyzed using the Shapiro–Wilk test to determine the normality of the data and homogeneity test using the Levene test. If the data is normally distributed, then the one-way ANOVA test is continued. If the results show a difference in meaning, then it is continued with the LSD post hoc test. Meanwhile, if the data is not normally distributed; then, the Kruskal–Wallis test is carried out and then the Mann–Whitney test. This also applies to the evaluation of number of osteoblasts, osteocytes, and osteoclasts by HE staining, BALP and calcium levels in the blood. The evaluation percentage of callus growth around bone defects was assessed by means of Lane–Sandhu scoring. Evaluation of VEGF and osteocalcin expression using immunohistochemistry was performed semi-quantitatively via the Remmele method. The three tests were analyzed using the Kruskal–Wallis test, and assessment was continued with the Mann–Whitney test if there were significant differences between groups.

3. Results

3.1. Characterizations of Pellet

The results of the SEM identification show that the resulting pellet has a hexagonal particle shape with a particle size mean of $1.350 \pm 0.243 \mu\text{m}$ (Mean \pm SD) (Figure 1a). The results of the FT-IR from BHA describe the percentage of transmission at the specific wave numbers $\text{PO}_4 = 1048.57 \text{ cm}^{-1}$, $\text{OH} = 3571.03 \text{ cm}^{-1}$, and $\text{CO}_3 = 1460.65 \text{ cm}^{-1}$, which are the harsh characteristics of bovine hydroxyapatite. Meanwhile, the result of the assessment in gelatin describe the emergence of the percentage of transmission in $\text{OH}; \text{NH}_2; = 3500\text{--}3000 \text{ cm}^{-1}$; $\text{C}=\text{O}$ and $\text{NH} = 1655\text{--}1540 \text{ cm}^{-1}$; $\text{COO} = 1450\text{--}1240 \text{ cm}^{-1}$ (Figure 1b–d).

3.2. Radiology Examination

A study on the effect of oral BHA or calcium lactate on the repair of bone defects, implanted with BHA–GEL pellets, was carried out using a burr hole defect model in the cortical bone of the rabbit femur. Defects with implants appear circular, with higher intensity than their surroundings. The radiographic results showed that the implant group experienced accelerated bone growth in the area of the defect compared to the group without implants. The pellet intensity in the implant + oral BHA group was known to be fainter than that in the implant + oral calcium lactate group (Figure 2a,b), indicating the union of bone with the composite. The results of the evaluation of bone gap closure-obtained data that were not normally distributed ($p < 0.05$) nor homogeneous ($p < 0.05$) in the termination group on days 7, 14 and 28. Furthermore, using the Kruskal–Wallis, it was found that there was no difference which was significant ($p > 0.05$) between groups for each termination period (Figure 2c). The development of bone regeneration can also be known based on callus formation, which is characterized by changes in the intensity and transformation of the implants implanted. The longer treatment times showed the intensity of the pellets was fading, but the radiological results did not describe the percentage of callus growth so that it was continued with macroscopic observations. Lane–Sandhu scoring results (macroscopic observation) showed that the longer the treatment time, the higher the percentage of callus growth. The data generated from the scoring process includes non-parametric data so that the test carried out is Kruskal–Wallis and shows a sig. value ($p > 0.05$), or there is no significant difference between groups in each termination period (Figure 2d).

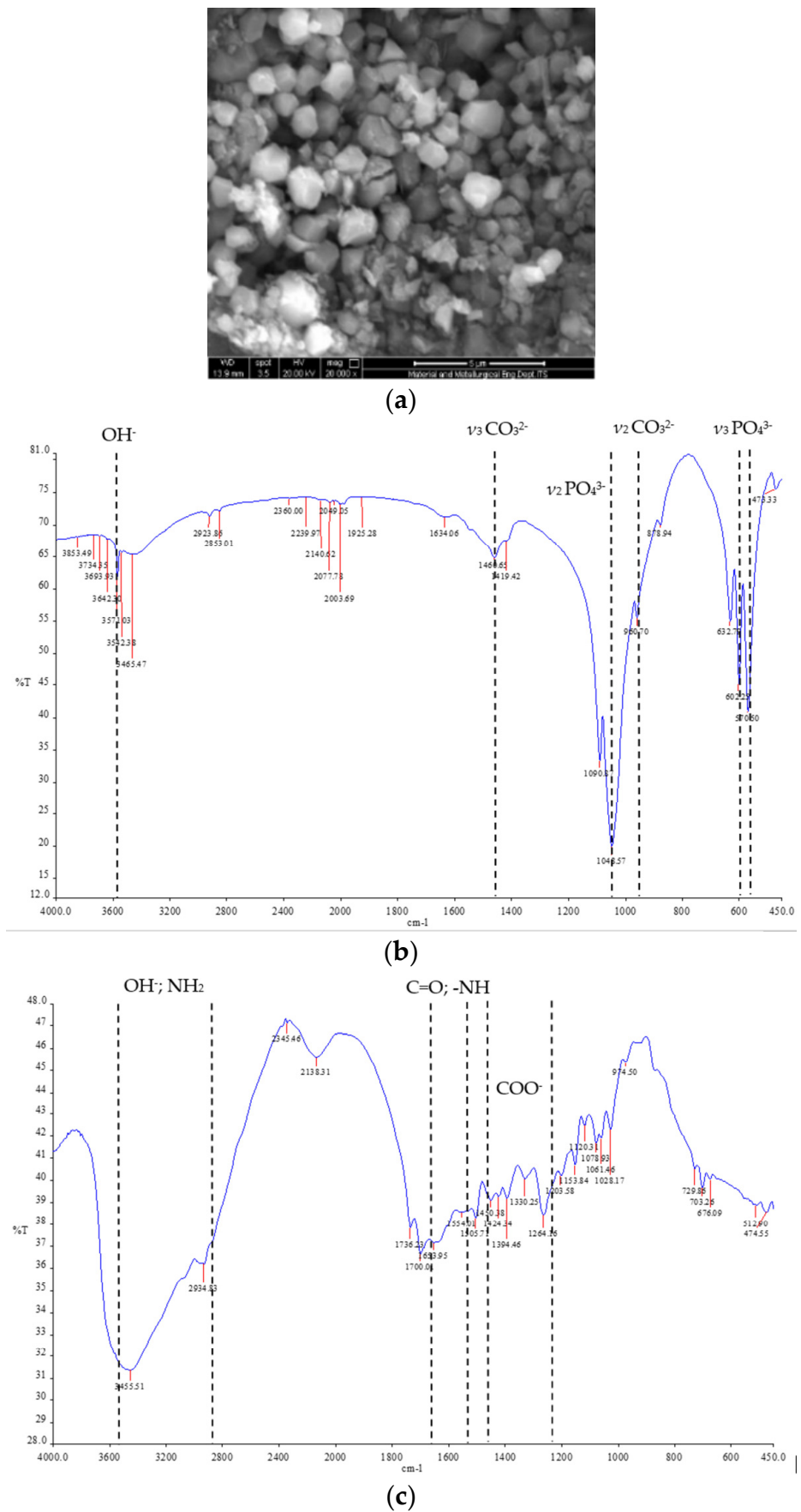


Figure 1. Cont.

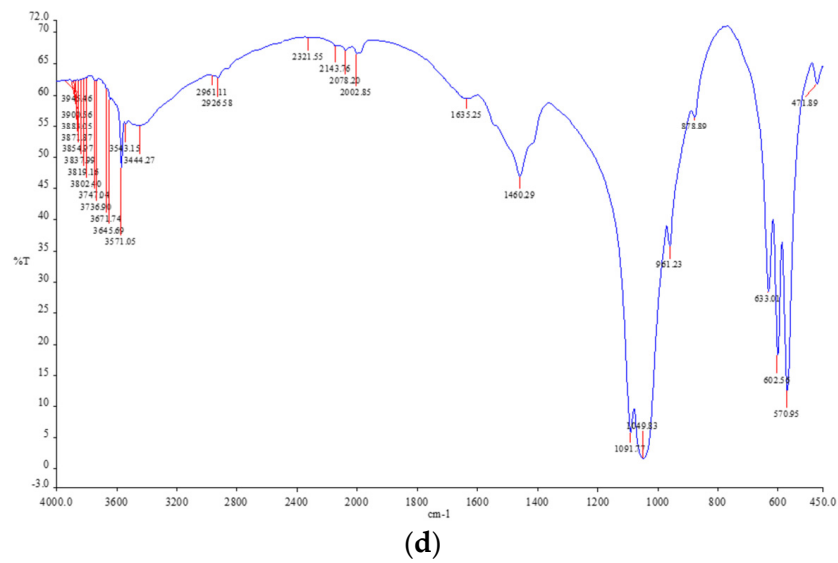
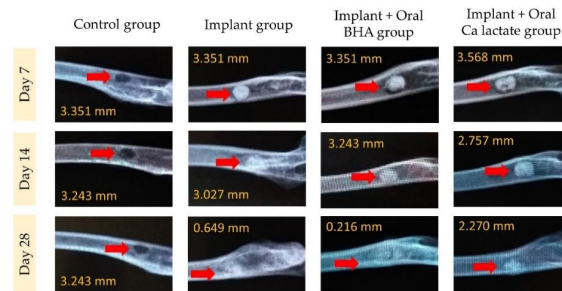
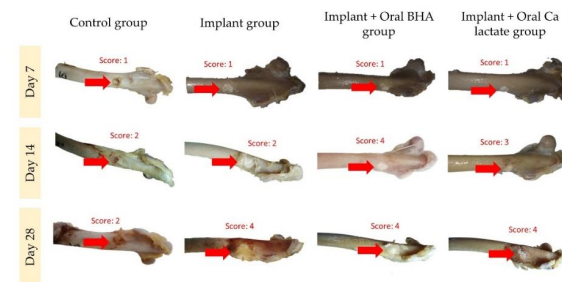


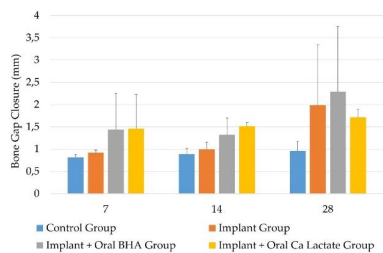
Figure 1. (a) Representative of SEM Scanning Result of BHA–GEL Pellet; (b) FT-IR Spectra Profile of BHA (c) FT-IR Sepctra Profile of Gelatin; (d) FT-IR Spectra Profile of BHA–GEL Pellet.



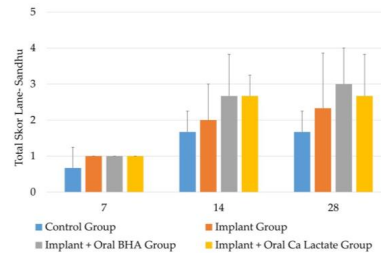
(a)



(b)



(c)

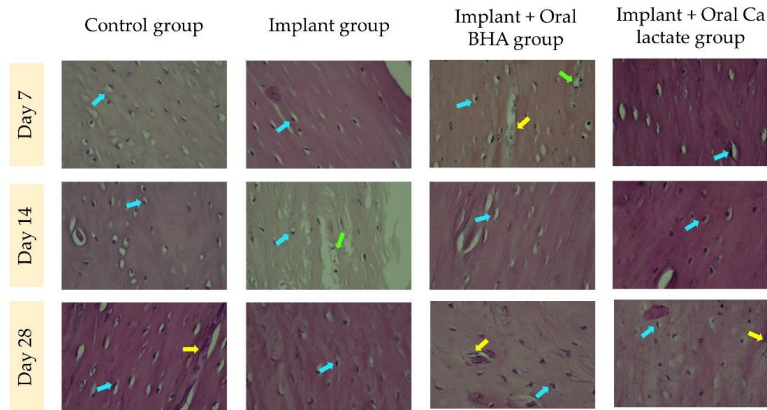


(d)

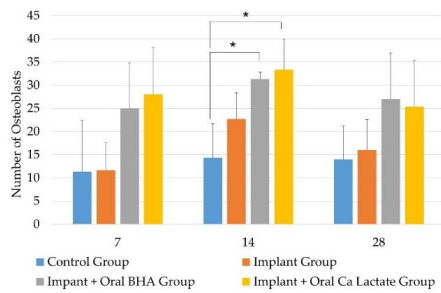
Figure 2. (a) X-ray radiology results of rabbit femur (1024 × 1024 pixel); (b) rabbit femur bone macroscopic; (c) result of measurement of bone cleft closure; (d) calculation results with Lane–Sandhu Scoring. The red arrow in subfigures (a,b) indicates the location of the defect. The implanted group showed accelerated bone growth in the defect area.

3.3. Examination of the number of Osteoblasts, Osteoclasts and Osteocytes through Hematoxylin-Eosin Staining

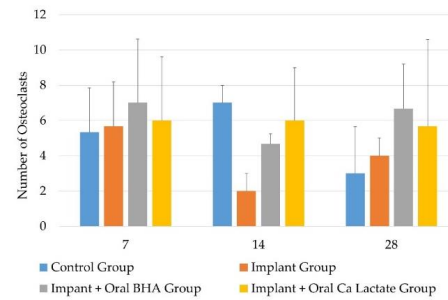
The data from the observation of osteoblast cells (Figure 3a) obtained showed that the data were normally distributed ($p > 0.05$) and homogeneous ($p > 0.05$) for each termination period. On days 7 and 28, there was no significant difference (one-way ANOVA; $p > 0.05$) between groups. Meanwhile, on the 14th day, it was known that the implant + oral BHA and implant + oral calcium lactate groups were significantly different (one-way ANOVA post hoc LSD; $p < 0.05$) compared to the defect group (control) (Figure 3b).



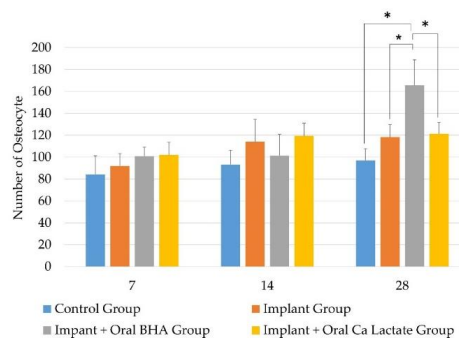
(a)



(b)



(c)



(d)

Figure 3. (a) Observation of bone cells with *Hematoxylin-Eosin* staining, magnification 400×. Osteoblast (yellow arrows), osteoclast (green arrows), and osteocyte (blue arrows); (b) observation of the number of osteoblast cells; (c) observation of the number of osteoclast cells; (d) observation of the number of osteocyte cells. The sign (*) indicates $p < 0.05$ with one-way ANOVA post hoc LSD test.

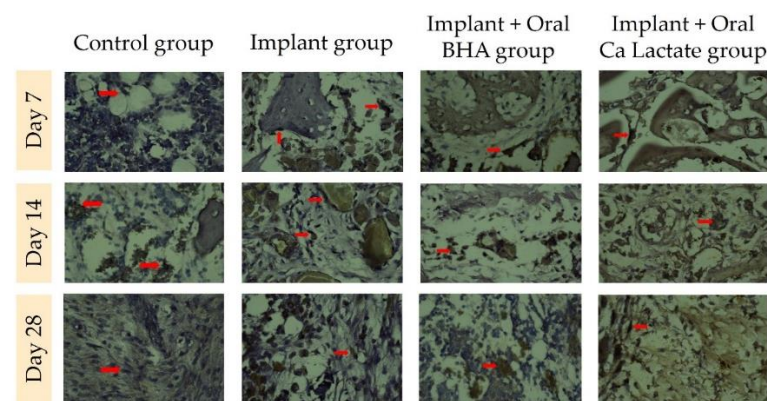
The data from the observation of osteoclast cells (Figure 3a) on days 7 and 28 were normally distributed ($p > 0.05$) and homogeneous ($p > 0.05$), and there was no significant difference (one-way ANOVA; $p > 0.05$) between groups. On day 14 the data were not

normally distributed ($p < 0.05$) and there was no significant difference (Kruskal–Wallis; $p > 0.05$) between groups (Figure 3c).

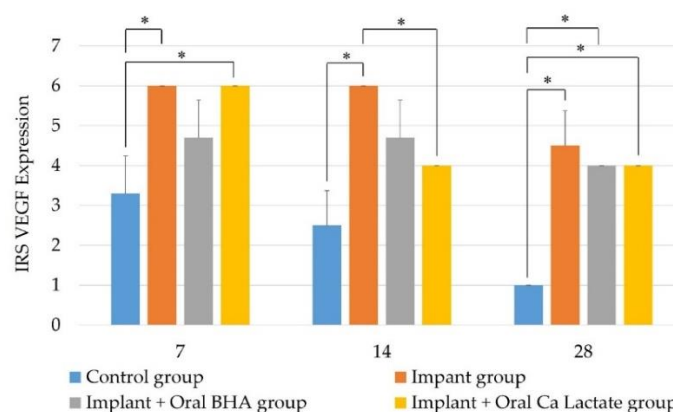
The data from the observation of osteocyte cells (Figure 3a) obtained data that were normally distributed ($p > 0.05$) and homogeneous ($p > 0.05$) for each termination period. On days 7 and 14 there was no significant difference (one-way ANOVA; $p > 0.05$) between groups. Meanwhile, on day 28, it was found that the implant + oral BHA group was significantly different from the defect group (control), the implant group and the implant + oral calcium lactate group (one-way ANOVA post hoc LSD; $p < 0.05$). This indicates the effect of the addition of oral BHA on the number of osteocyte cells (Figure 3d).

3.4. Examination of the Amount and Distribution of VEGF through Immunohistochemistry

Immunohistochemical examination with anti-VEGF was performed to determine the vascularity of bone tissue in each treatment group. The results of the observation of VEGF expression using the Kruskal–Wallis test analysis in the negative control group, the implant group, the implant + oral BHA group, and the implant + oral calcium lactate group at 7, 14, and 28 days (Figure 4b) showed different values. VEGF expression was calculated ($p < 0.05$). When the results of VEGF expression in the implant and oral BHA group and the implant and oral calcium lactate group on days 7, 14, and 28, there was no difference in VEGF expression value ($p > 0.05$) with the Mann–Whitney test.



(a)

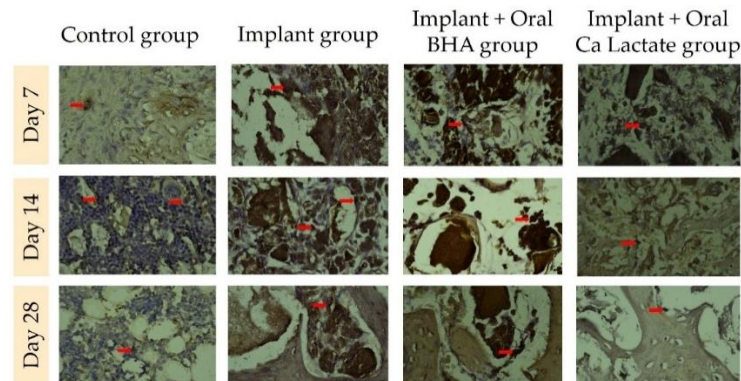


(b)

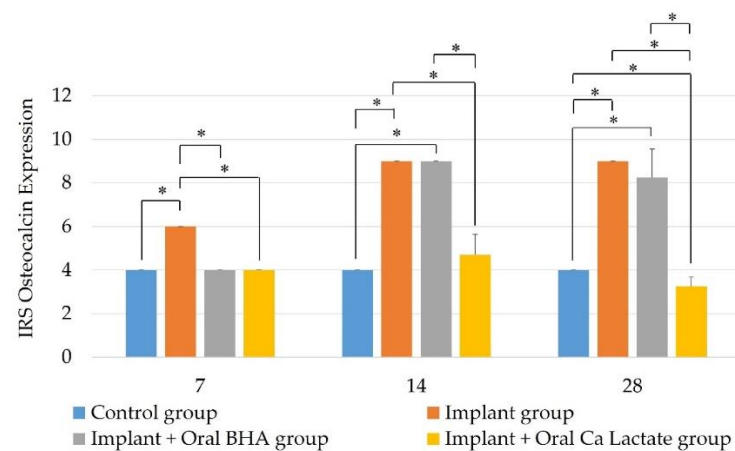
Figure 4. (a) Immunohistochemistry of VEGF expression (400× magnification). VEGF-positive cells are indicated by brown osteoblasts (red arrows); (b) differences in IRS values of VEGF expression, each bar graph represents $IRS \pm SD$. The sign (*) indicates $p < 0.05$ with the Mann–Whitney Test.

3.5. Examination of the Amount and Distribution of Osteocalcin through Immunohistochemistry

Immuno-histochemical examination with anti-osteocalcin was performed to determine the number of osteoblasts which are markers of mineral deposition and growth of mature callus in each treatment group. The results of observations of osteocalcin expression in the negative control group, implant group, implant + oral BHA group, and implant + oral calcium lactate group at 7, 14, and 28 days (Figure 5b) showed differences in the value of osteocalcin expression ($p < 0.05$) with the Kruskal–Wallis test. On days 14 and 28, the implant + oral BHA group showed higher IRS scores than the implant + calcium lactate group (Mann–Whitney; $p < 0.05$).



(a)



(b)

Figure 5. (a) Immunohistochemistry of osteocalcin expression (400× magnification). Osteocalcin-positive cells are indicated by brown osteoblasts (red arrows); (b) differences in IRS values of osteocalcin expression, each bar graph representing IRS ± SD. The sign (*) indicates $p < 0.05$ with the Mann–Whitney Test.

3.6. Examination of BALP Levels through ELISA

The results of measurements of BALP levels obtained data that were normally distributed ($p > 0.05$) and homogeneous ($p > 0.05$). There was a significant difference between the implant + oral BHA group and the implant + oral calcium lactate compared to the defect and implant groups on day 7. Meanwhile, on day 14, there was a significant difference between the defect group with an implant, an implant + oral BHA, and an implant + oral calcium lactate (One-way ANOVA post hoc LSD; $p < 0.05$) (Figure 6a).

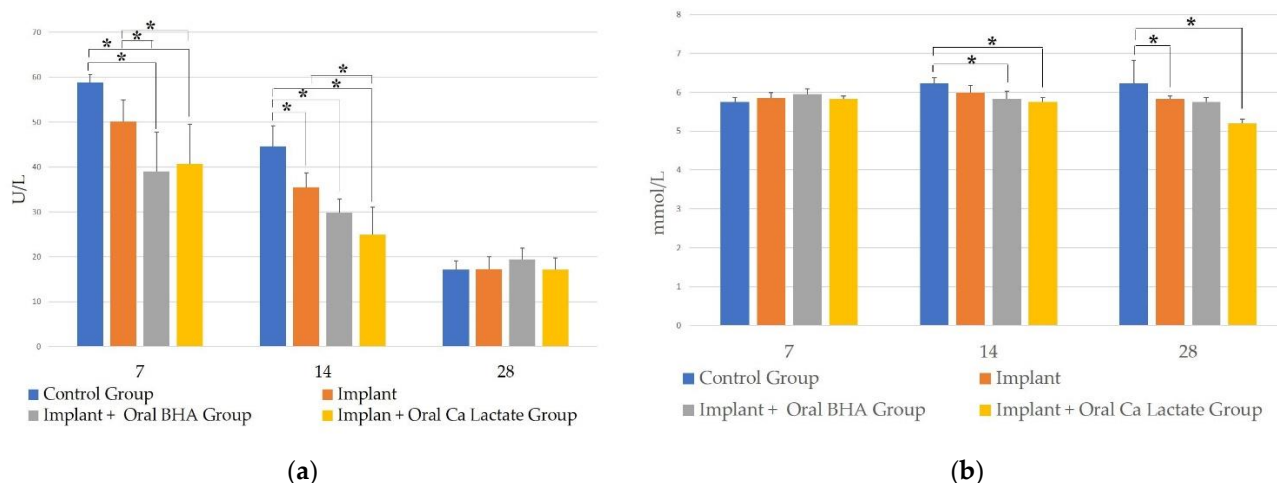


Figure 6. (a) BALP level examination results; (b) results of examination of calcium levels sign (*) indicates $p < 0.05$ in post hoc LSD test.

3.7. Examination of Calcium Levels in the Blood through the Calcium Colorimetric Assay Kit

The results of the measurement of calcium levels in the blood obtained data that were normally distributed ($p > 0.05$) and homogeneous ($p > 0.05$). There was a significant difference between the defect group with implant + oral BHA, implant + oral calcium lactate on day 14. Meanwhile, on day 28 there was a difference between the defect group with implant and implant + oral calcium lactate (one-way ANOVA post hoc LSD; $p < 0.05$) (Figure 6b).

4. Discussion

An *in vivo* study to test the effectiveness of oral BHA and calcium lactate in conjunction with BHA–GEL implants was performed on femoral bone defects in rabbits. Based on previous studies, BHA–GEL implants showed accelerated bone growth in terms of the percentage of new bone and bone-composite contact [10]. Castelo et al. [28] stated that the ossein hydroxyapatite complex (OHC) consisting of ossein, a protein that forms the organic matrix of bone and hydroxyapatite ($\text{Ca}_5[\text{PO}_4]_3\text{OH}$) has been shown to be effective in maintaining bone mineral density (BMD) and has a strong osteogenic effect which is stronger than calcium supplements. Other studies have shown that OHC stimulates bone metabolism by stimulating osteoblast differentiation, activity, and proliferation [29]. OHC has been shown to reduce the rate of bone resorption and stimulate ossification. Administration of OHC as monotherapy for 1–4 weeks in fracture patients has shown a reduction in the time required for healing by stimulating callus formation, thereby accelerating consolidation and clinical improvement [30].

From the characterizations of the pellet, the morphological shape of the particle was hexagonal, with a particle size mean of $1.350 \pm 0.243 \mu\text{m}$ (mean \pm SD). This is in line with previous studies of natural hydroxyapatite, one of which shows BHA possess a hexagonal particle shape [31,32]. Several factors that can influence the morphology of the particles are changes in the calcination temperature, as described by Khoo et al. [33]. Then, the FTIR spectra showed the specific wave number of functional group of the structure as well as the BHA–GEL pellet. The band at 1048 cm^{-1} is attributed to an asymmetric stretching vibration mode ν_3 of PO_4^{3-} , while two sharp peaks at 570 and 602 cm^{-1} are attributed to asymmetric bending vibration mode ν_3 , and symmetric bending vibration mode ν_2 of PO_4^{3-} group. The bands observed at 962 and 1458 cm^{-1} at the FTIR spectra indicate the presence of B-type carbonate CO_3^{2-} bands [34].

Radiological results revealed the development of bone growth; after measuring bone gap closure, it was found that the implant + oral BHA group (the average diameter on day 28 is 1.910 mm) had a smaller final diameter of the bone gap than the implant + oral calcium lactate group (the average diameter on day 28 is 2.487 mm). This is supported by

the observation of callus growth in bone defects, where changes in transformation and pellet intensity were more faded in the implant + oral BHA group. This indicated the growth of new tissue that was fused (union) with the bone due to the penetration of tissue cells around the bone into the implant.

The reparative process of bone fractures involves a series of events that include migration, proliferation, differentiation and activation of several cell types. These include mesenchymal and hematopoietic stem cells that ultimately lead to bone formation and remodeling [35]. These stem cells will differentiate into several types of bone cells, including osteoblasts and osteoclasts, while osteocytes are transformed osteoblasts that are embedded in the bone matrix. All three cells were expressed by *Hematoxylin-Eosin* staining. On day 14, it was found that the osteoblast cells in the implant + oral BHA group were significantly different from the defect group (control). In accordance with the previous theory, where BHA has a carbonate group which is known to increase the proliferation and differentiation of osteoblasts as well as mesenchymal stem cells which are osteoprogenitor cells that produce osteoblasts, thus bone matrix synthesis occurs more quickly [36]. Furthermore, there was also a significant difference between the implant + oral calcium lactate group and the defect group (control). In previous studies, it was stated that calcium lactate can increase extracellular calcium and intracellular calcium levels, thereby stimulating bone formation significantly, as well as increasing osteoblast proliferation or chemotaxis [22]. The same thing was observed in the observation of the number of osteocytes, where an increase in osteoblast proliferation would result in more mineralized osteoid so that the number of osteocytes also increased.

Osteoclasts on day 14 of the defect group (control) increased, indicating that the activity of mature osteoclasts was maximal in resorption of bone in the second week. However, in the group with the implant, the number of osteoclasts was lower than in the defect group (control). This may have been because the group with the implant treatment or the addition of calcium supplements had accelerated fracture healing. Substitution of carbonate contained in BHA causes bioresorption to occur earlier [37]. Increased osteoclastogenesis accelerates cartilage resorption and increased osteoblastogenesis during fracture healing promotes bone fusion, whereas inhibition of osteoclast or osteoblast differentiation has been reported to delay bone healing [38]. The processes of resorption by osteoclasts and bone formation by osteoblasts proceed sequentially but overlap substantially, so that there is a change in the cell population that indicates regeneration in the tissue [2]. This can be seen through the results of research where when there is an increase in the number of osteoblasts, the number of osteoclasts decreases, or vice versa.

Parameters measured by the IHC method were vascular endothelial growth factor (VEGF) and osteocalcin. VEGF is a protein that plays an important role in endothelial proliferation, migration, and activation [39]. VEGF can be detected in the first week after injury, namely in the inflammatory phase [40]. The results of the examination of VEGF expression in the implant + oral BHA group compared to the implant + oral calcium lactate group on days 7, 14, and 28 showed no significant difference. This is probably because VEGF expression in the implant + oral BHA group was seen on day 3, and then peaked on day 5 [41]. In the implant + oral BHA group, there may have been a decrease in the number of macrophages, so that VEGF expression decreased. This decrease was influenced by a decrease in the number of blood vessels damaged in the wound; the extracellular matrix begins to fill the missing area and stable blood vessels begin to form [42]. Based on this study, the implant + oral BHA group was found to be effective in increasing VEGF expression on day 14 compared to the implant + oral calcium lactate group based on the IRS value of VEGF expression.

Osteocalcin is a non-collagenous protein that has an important role in the mineralization process and calcium ion homeostasis [43,44]. The results of the examination of osteocalcin expression in this study were all groups experienced an increase in osteocalcin expression since day 14. This is in line with the research of Jafary et al. [45], which states that an increase in osteocalcin can be detected at week 2, which is day 14. Osteocalcin

can be detected in mature callus [4]. Mature callus begins to form from the repair phase to the remodeling phase [20]. Osteoblast maturation was demonstrated by increasing the value of osteocalcin expression [43]. Osteocalcin plays an important role in regulating mineral nucleation by binding to hydroxyapatite. Based on the study, the value of osteocalcin expression on days 14 and 28 showed a higher value of osteocalcin expression in the implant + oral BHA group than the implant + oral calcium lactate group. This is because BHA increases the proliferation of hydroxyapatite by stimulating mesenchymal cells, resulting in faster hard callus formation [18].

These results were also similar to the results of measuring BALP levels, where the group receiving oral BHA had higher BALP levels than the oral calcium lactate group. Bone alkaline phosphatase (BALP) is a metalloenzyme that is produced when osteoblast cells work [46]. High expression of BALP indicates better activity where BALP is useful in the synthesis of collagen fibers and in bone mineralization. On the 7th day, BALP levels were higher than the 14th and 28th days which could be due to the process of differentiation of osteoblasts. This is also in accordance with the theory which states that bone alkaline phosphatase (BALP) is a metalloenzyme that is produced when osteoblast cells work [46,47]. Osteoblasts will express collagen, which plays a role in the process of bone mineralization to a form soft callus. This is also in accordance with the statement of Einhorn and Gerstenfeld [2], and on the 7th day it enters the proliferative or endochondral phase where the soft callus begins to form. Soft callus growth also occurs because the gelatin contained in the implant is degraded to form type 1 collagen which is the main constituent of bone [8]. On the 14th day BALP levels decreased compared to the 7th day; this is because at this stage the process of fibrous tissue formation has occurred and soft callus maturation has begun, which has occurred on the 7th day [2]. On day 14, the mean number of osteoblasts also decreased as, according to the matrix maturation phase, osteoblasts lost their function and differentiated into osteoid in the bone [48]. On day 28, BALP also decreased, which could be due to the near-complete fracture healing process [49]. Birmingham et al. [50] also stated that the differentiation of osteoblast cells occurred at the beginning of day 5 to 14, after which there was a decrease in BALP expression. In addition, the results of the examination of higher blood calcium levels in the implant + oral BHA group compared to the implant + oral calcium lactate group will also increase the proliferation and/or chemotaxis of osteoblasts, thereby stimulating bone formation significantly.

Calcium lactate is known to be highly soluble and has high bioavailability; however, hydroxyapatite, which is generally considered insoluble, shows absorption values one-fourth to one-third as good as the most soluble preparations [51]. Hydroxyapatite raises blood calcium levels less than calcium carbonate and calcium citrate. This indicates that hydroxyapatite is more effective in entering bone cells [18]. In addition, *in vitro* examination of bone cell cultures showed that the organic part of OHC contains factors that influence osteoblast proliferation [13]. This causes the bone growth of the implant + oral BHA group to be better than the implant + oral calcium lactate group. BHA also has a carbonate group that is naturally present in human bone and that can be found in synthetic biomimetic hydroxyapatites. Carbonated hydroxyapatite is known to increase protein adsorption and increase adhesion, proliferation, and osteogenic differentiation of mesenchymal stem cell tissue. In addition, carbonated hydroxyapatite is also known to increase the proliferation and differentiation of osteoblasts, thereby increasing bone matrix synthesis [36]. The same thing happened in the study by Castelo et al. [29], based on histological observations of bone using a fluorescent microscope showed that oral administration of ossein hydroxyapatite could increase bone formation compared to the group given hydroxyapatite alone or with calcium carbonate. In addition, this is influenced by the absorption to the bioavailability of the two supplements given. It is known that the absorption of microcrystalline hydroxyapatite compound (MCHC) is about 42.5% [19], and it is higher than the absorption of calcium lactate which is around 25% [24]. The results showed that the bioavailability of calcium lactate in rats was 8.9 + 1.4% [52]. Meanwhile, hydroxyapatite is reported

to have better bioavailability than calcium carbonate [14], and as good as or better than calcium gluconate [53].

5. Conclusions

BHA supplements, given orally together with BHA–GEL pellet implants, showed faster healing of bone defects compared to oral calcium lactate with BHA–GEL pellet implants.

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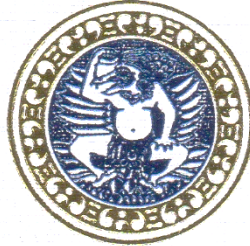
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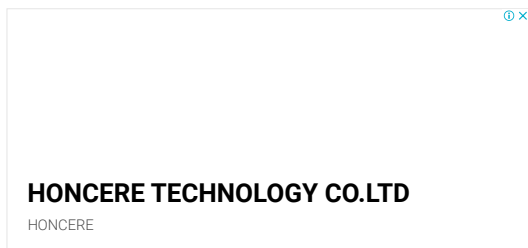
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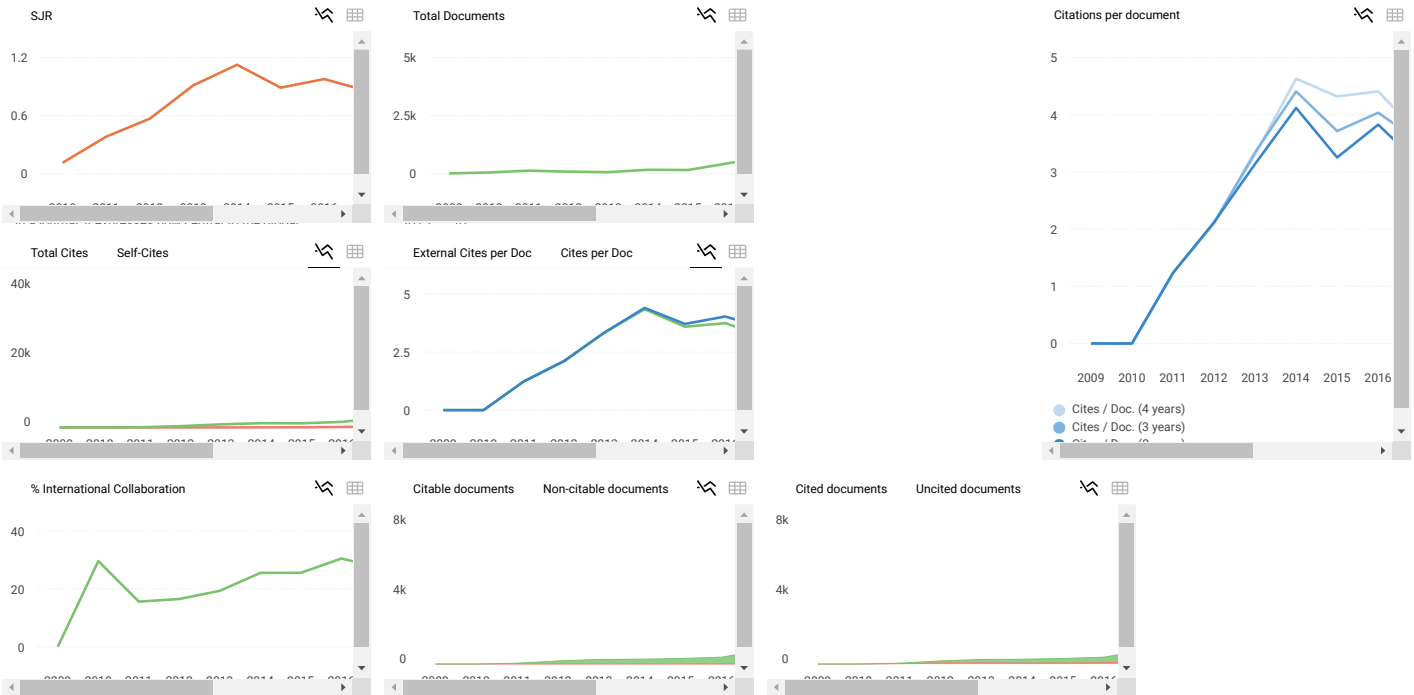
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