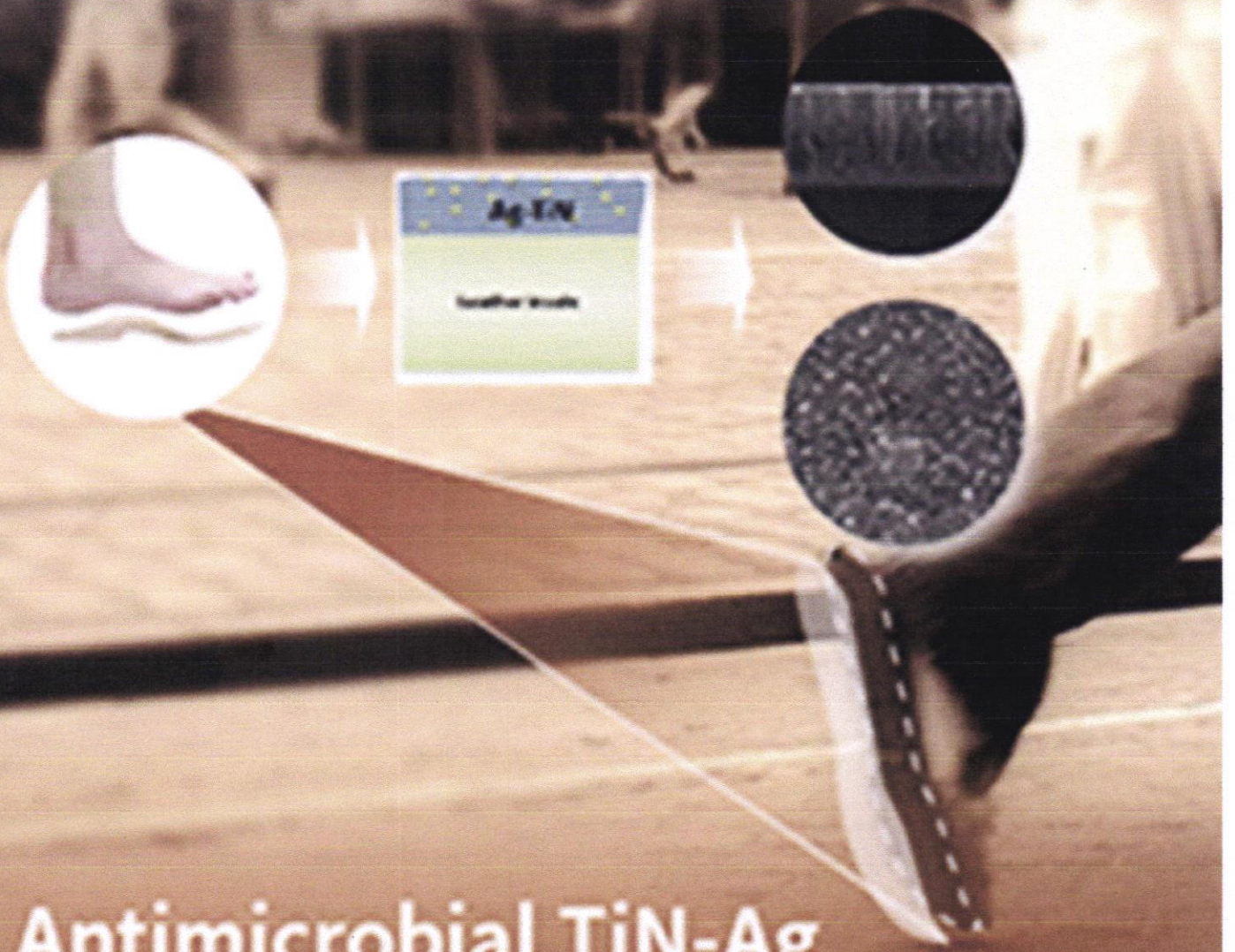




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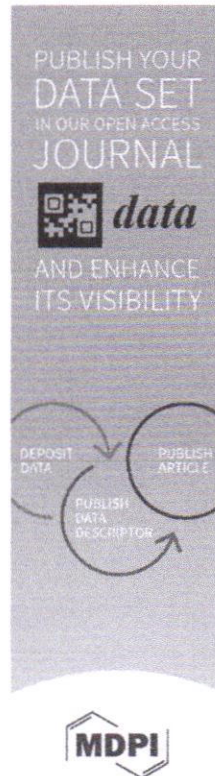
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Editor-in-Chief

James McGill Professor, Professor of Biomedical Engineering, Professor of Bioengineering, Professor of Experimental Surgery, Department of Biomedical Engineering, Faculty of Medicine/Faculty of Dentistry, Duff Medical Science Building, 3775 University Street, Montreal, QC H3A 2B4, Canada

Interests: cell-biomaterial interactions; LbL self-assembly systems; theranostic devices for gene/protein therapy and tissue engineering; nanostructured interface by surface molecular engineering; microfluidic platforms for biorecognition systems and Lab-on-a-chip devices; real-time monitoring of cellular activities; characterization of biomaterials debris in biological tissues; polymer synthesis and characterization

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[Website \(https://www.ntnu.edu/employees/filippo.berto\)](https://www.ntnu.edu/employees/filippo.berto) [SciProfiles \(https://sciprofiles.com/profile/281379\)](https://sciprofiles.com/profile/281379)

Associate Editor-in-Chief

Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, 7491 Trondheim, Norway

Interests: fatigue and fracture behavior of materials; mechanical characterization; structural integrity of conventional and innovative materials

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Prof. Dr. Guillermo Requena

[Website \(https://www.dlr.de/wf/en/desktopdefault.aspx/tabid-2447/3634_read-5395/\)](https://www.dlr.de/wf/en/desktopdefault.aspx/tabid-2447/3634_read-5395/) [SciProfiles \(https://sciprofiles.com/profile/538955\)](https://sciprofiles.com/profile/538955)

Associate Editor-in-Chief

Department of Metallic Structures and Hybrid Materials Systems, Institute for Materials Research, German Aerospace Centre, Linder Höhe, 51147 Cologne, Germany

Interests: light alloys; metals for additive manufacturing; three-dimensional material characterization; synchrotron tomography; high energy synchrotron diffraction; aluminum alloys; titanium alloys; magnesium alloys; titanium aluminides; metal matrix composites; phase transformations; relationships microstructure-properties; thermo-mechanical behavior of metals

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Dr. Christof Schneider

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Associate Editor-in-Chief

Thin Films and Interfaces Group, Research with Neutrons and Muons Division (NUM), Paul Scherrer Institut, CH-5232 Villigen, Switzerland

Interests: oxide materials for energy applications: thermoelectrics, ion conductors, battery materials; Pulsed Laser Deposition (PLD); multiferroics; interface physics of oxides with strong electronic correlations



Prof. Dr. Xiaoyan Li *

[Website1 \(http://www.hy.tsinghua.edu.cn/publish/hyen/1694/2017/20171218162103692138689/20171218162103692138689_.html\)](http://www.hy.tsinghua.edu.cn/publish/hyen/1694/2017/20171218162103692138689/20171218162103692138689_.html) [Website2 \(http://www.xiaoyanlithu.com/\)](http://www.xiaoyanlithu.com/)

Section Editor-in-Chief

Department of Engineering Mechanics, Tsinghua University, Beijing 100084, China

Interests: carbon materials; nanostructured materials; energy storage materials and mechanical metamaterials

* Section EiC of Mechanics of Materials

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Website (<https://www.researchgate.net/profile/Panagiotis-Asteris>) **SciProfiles** (<https://sciprofiles.com/profile/163850>)

Section Editor-in-Chief

Department of Civil Engineering, School of Pedagogical & Technological Education, Athens, Greece

Interests: sustainability and resilience; reinforced concrete structures; durability

* Section EiC of Materials Simulation and Design

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Website (<http://www.composites.polito.it/>) **SciProfiles** (<https://sciprofiles.com/profile/191>)

Section Editor-in-Chief

Institute of Materials Physics and Engineering, Department of Applied Science and Technology, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129

Turin, Italy

Interests: bioactive glasses; bioceramics; composites; tissue engineering; multifunctional biomaterials; biomedical scaffolds; additive manufacturing; advanced ceramics

* Section EiC of Advanced and Functional Ceramics

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Prof. Dr. Stefano Bellucci *

Website (http://www.unisrta.com/dipartimenti/fisica-e-scienza-dei-sistemi/prof-stefano-bellucci/?doing_wp_cron=1537925959.0764439105987548828125) **SciProfiles** (<https://sciprofiles.com/profile/538649>)

Section Editor-in-Chief

INFN-Laboratori Nazionali di Frascati, 00044 Frascati, Italy

Interests: theoretical physics; condensed matter; biophysics; physical chemistry; nanoscience and nanotechnology; nanocarbon-based composites; biomedical applications

* Section EiC of Carbon Materials

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Prof. Dr. Teofil Jesionowski *

Website (<https://www.fct.put.poznan.pl/pl/kadra/73>) **SciProfiles** (<https://sciprofiles.com/profile/68595>)

Section Editor-in-Chief

Institute of Chemical Technology and Engineering, Faculty of Chemical Technology, Poznan University of Technology, Berdychowo 4, PL-60965 Poznan, Poland

Interests: biopolymers; synthesis, characterization and applications of advanced functional materials; functional fillers and polymer composites; (bio)additives and eco-friendly fillers; biomineralization-inspired syntheses and extreme biomimetics; biocomposites and biomaterials; removal of wastewater pollutants via adsorption; photocatalysis or precipitation methods; pigment composites; enzyme immobilization; colloid chemistry and surface modification; hybrid systems; biosensors

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Website (https://ants.snu.ac.kr/?page_id=13) **SciProfiles** (<https://sciprofiles.com/profile/405461>)

Section Editor-in-Chief

Mechanical Engineering, Seoul National University, Seoul, Korea

Interests: sustainable energy devices; nanomaterial synthesis and characterization; microscale heat transfer; flexible and stretchable electronics

* Section EiC of Smart Materials

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Prof. Dr. Eddie Koenders *

Website (<https://www.wib.tu-darmstadt.de/wib/institut.de.jsp>) **SciProfiles** (<https://sciprofiles.com/profile/624290>)

Section Editor-in-Chief

Institute of Construction and Building Materials, Technical University of Darmstadt, Darmstadt, Germany

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Interests: multiscale modeling; modeling hydration and transport; sustainable binders; thermal energy storage; ultralight foams

* Section EIC of Construction and Building Materials

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Prof. Dr. Vlassios Likodimos *

Website (<http://scholar.uoa.gr/vlikodimos>) **SciProfiles** (<https://sciprofiles.com/profile/520443>)

Section Editor-in-Chief

Section of Condensed Matter Physics, Department of Physics, National and Kapodistrian University of Athens, University Campus, GR-157 84 Zografou, Athens

Interests: photocatalytic materials; nanostructured titanium dioxide; carbon nanomaterials; metal oxides

* Section EIC of Materials Physics

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Website (<http://faculty.csu.edu.cn/yclin>) **SciProfiles** (<https://sciprofiles.com/profile/113245>)

Section Editor-in-Chief

School of Mechanical and Electrical Engineering, Central South University, Changsha 410083, China

Interests: alloys; intelligent manufacturing processing; heat treatment; microstructure; deformation mechanisms; properties

* Section EIC of Metals and Alloys

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Prof. Dr. Rafael Luque *

★ (<https://recognition.webofsciencegroup.com/awards/highly-cited/2020/>) **Website** (<http://www.uco.es/users/q62alsor/contact.html>)

SciProfiles (<https://sciprofiles.com/profile/451196>)

Section Editor-in-Chief

Departamento de Química Orgánica, Universidad de Córdoba, Campus de Rabanales, Edificio Marie Curie (C-3), Ctra Nnal IV-A, Km 396, Córdoba, Spain

Interests: green chemistry; biomass valorization; heterogeneous catalysis; nanomaterial design

* Section EIC of Porous Materials

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Prof. Dr. Sanjay Mathur *

Website (<http://www.mathur.uni-koeln.de>) **SciProfiles** (<https://sciprofiles.com/profile/10925>)

Section Editor-in-Chief

Inorganic and Materials Chemistry, University of Cologne, Institute of Inorganic Chemistry, Greinstraße 6, D-50939 Cologne, Germany

Interests: molecular precursor libraries; precursor-derived materials; nanostructured materials; chemical vapor deposition; atomic layer deposition; sol-gel; nanofibers and nanowires; batteries; photovoltaics; solar hydrogen

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Prof. Dr. Alessandro Pegoretti *

Website (<http://www.ing.unitn.it/~pegoretti/>) **SciProfiles** (<https://sciprofiles.com/profile/137094>)

Section Editor-in-Chief

Department of Industrial Engineering, University of Trento, 38121 Trento, Italy

Interests: deformation, yield and fracture mechanics of polymers and composites; processing and characterization of multiphase polymeric materials (micro- and nanocomposites, blends); durability of polymeric and composite materials; environmentally sustainable polymers and composites (biodegradable, from renewable resources, fully recyclable); polymers and composites with functional properties (electrical conductivity, shape memory, strain and damage monitoring, self-healing, etc.)

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1. van 't Hoff Laboratory for Physical & Colloid Chemistry, Debye Institute for Nanomaterials Science, Utrecht University, Utrecht, The Netherlands
2. Laboratory of Physical Chemistry, Eindhoven University of Technology, Eindhoven, The Netherlands

Interests: colloids and nanoparticles; self-organisation; colloidal crystals; colloidal liquid crystals; chiral colloids; active matter and dissipative assembly; advanced synchrotron scattering techniques; microscopy at the nanoscale

* Section EIC of Advanced Nanomaterials and Nanotechnology

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[Website \(http://astro1.panet.utoledo.edu/~npodraza/index.html\)](http://astro1.panet.utoledo.edu/~npodraza/index.html)

Section Editor-in-Chief

Department of Physics and Astronomy & Wright Center for Photovoltaics Innovation and Commercialization, University of Toledo, Toledo, OH, USA

Interests: thin films; optical properties; spectroscopic ellipsometry; photovoltaics

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Dr. Fabrizio Roccaforte *

[Website \(https://www.imm.cnr.it/users/fabrizioroccaforte\)](https://www.imm.cnr.it/users/fabrizioroccaforte) [SciProfiles \(https://sciprofiles.com/profile/674766\)](https://sciprofiles.com/profile/674766)

Section Editor-in-Chief

CNR-IMM, Strada VIII, n. 5 - Zona Industriale, I-95121 Catania, Italy

Interests: wide band gap semiconductors (WBG); silicon carbide (SiC); gallium nitride (GaN); gallium oxide (Ga₂O₃), metal/semiconductor and metal/oxide/semiconductor interfaces; Schottky diode; JBS; MOSFET; HEMT; WBG device processing; power- and high-frequency electronics

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Section Editor-in-Chief

Departments of Mechanical & Aerospace Engineering and Chemical Engineering, Monash University, Melbourne, VIC 3800, Australia

Interests: materials degradation; corrosion; degradation of polymer and composites

* Section EIC of Corrosion and Materials Degradation

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Prof. Dr. Jens-Uwe Sommer *

[Website \(https://www.researchgate.net/profile/Jens-Uwe_Sommer\)](https://www.researchgate.net/profile/Jens-Uwe_Sommer) [SciProfiles \(https://sciprofiles.com/profile/87301\)](https://sciprofiles.com/profile/87301)

Section Editor-in-Chief

Leibniz-Institut für Polymerforschung Dresden e.V., Institute Theory of Polymers, Dresden, Germany

Interests: Theoretical Polymer and Biopolymer Physics; computer simulations in soft matter; Statistical Physics; polymers at interfaces; polymer networks; polymer solutions; polymer crystallization; polymers and nanoparticles

* Section EIC of Soft Matter

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Prof. Dr. Steven L. Suib *

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Section Editor-in-Chief

MDPI Department of Chemistry, University of Connecticut, 55 N. Eagleville Rd., Storrs, CT 06269-3060, USA

Interests: manganese oxides; catalysis; ceramics; nanotech; microwaves

* Section EiC of Catalytic Materials

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Website (<https://www.sgu.ru/en/person/tuchin-valery-victorovich>) **SciProfiles** (<https://sciprofiles.com/profile/1011087>)

Section Editor-in-Chief

Research-Educational Institute of Optics and Biophotonics, Saratov State University, 410012 Saratov, Russia

Interests: biological and medical physics; biophotonics; biomedical optics; laser spectroscopy and imaging in biomedicine; nonlinear dynamics of laser and optical systems; physics of optical and laser measurements; nanobiophotonics

* Section EiC of Optics and Photonics

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Website (<http://www.comoc.ugent.be>) **SciProfiles** (<https://sciprofiles.com/profile/53315>)

Section Editor-in-Chief

Department of Chemistry, Center for Ordered Materials, Organometallics and Catalysis (COMOC), Faculty of Sciences, Ghent University, Krijgslaan 281 (S3), 9000 Ghent, Belgium

Interests: ordered mesostructures; metal organic frameworks (MOFs); periodic mesoporous organosilicas; covalent organic frameworks; adsorption; catalysis and catalytic materials

* Section EiC of Advanced Materials Characterization

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Prof. Dr. Xuming Xie *

Website (<https://www.chemeng.tsinghua.edu.cn/info/1166/2602.htm>) **SciProfiles** (<https://sciprofiles.com/profile/1841711>)

Section Editor-in-Chief

Department of Chemical Engineering, Tsinghua University, Beijing 100084, China

Interests: super tough hydrogels; nanomaterials and nanocomposites; polymer blends; plastics recycling and value-added reuse

* Section EiC of Polymeric Materials

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Prof. Dr. Shouke Yan *

Website (<http://www.cmse.buct.edu.cn/gyxy/szdw/zjzg/zg/106347.htm>) **SciProfiles** (<https://sciprofiles.com/profile/411741>)

Section Editor-in-Chief

1. School of Materials Science and Engineering, Beijing University of Chemical Technology, Beijing 100029, China
2. School of Polymer Science and Engineering, Qingdao University of Science and Technology, Qingdao 266042, China

Interests: multiscale structure of polymeric materials; orientation induced polymer crystallization; surface induced polymer crystallization; confined polymer crystallization; polymer blends

* Section EiC of Polymeric Materials

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Prof. Dr. Heesun Yang *

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Section Editor-in-Chief

Department of Materials Science and Engineering, Hongik University, Seoul 04066, Korea

Interests: quantum dots; materials chemistry; photoluminescence; electroluminescence; light-emitting diodes

* Section EiC of Quantum Materials

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Prof. Dr. Mutlu Özcan *

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Website (<https://www.zzm.uzh.ch/en/research/staff/oezcan-mutlu.html>) **SciProfiles** (<https://sciprofiles.com/profile/1239817>)

Section Editor-in-Chief

Division of Dental Biomaterials, Clinic of Reconstructive Dentistry, Center of Dental Medicine, University of Zurich, 2032 Zurich, Switzerland

Interests: dental biomaterials; fixed prosthodontics; reconstructive dentistry; adhesive dentistry; minimally invasive dentistry

* Section EiC of Biomaterials

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Institute of Biomaterials, Department of Materials Science and Engineering, Friedrich-Alexander-University Erlangen-Nuremberg, 91058 Erlangen, Germany

Interests: bioactive glass; ceramics; composite coatings; hydroxyapatites

* Former Editor-in-Chief of Section "Biomaterials" from 2013 until July 2021

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Department of Materials Science and Engineering, The Iby and Aladar Fleischman Faculty of Engineering, Tel Aviv University, Tel Aviv 6997801, Israel

Interests: biomaterials; corrosion; electroplating; bio-ferrography; failure analysis; additive manufacturing



Prof. Dr. Hallong Jiang

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(<http://staff.ustc.edu.cn/~jianglab/Current%20Members.html>)

Department of Chemistry, Hefei National Lab for Physical Sciences at the Microscale, University of Science and Technology of China (USTC), Hefei 230026, China

Interests: metal-organic frameworks; porous materials; nanostructured materials; heterogeneous catalysis; photocatalysis



Dr. Khaled Parvez

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Department of Chemistry, University of Manchester, Oxford Road, M13 9PL Manchester, UK

Interests: graphene; two-dimensional materials; printed electronics; sensors; supercapacitors; bioelectronics; device fabrications; fuel cells

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Prof. Dr. Volker Abetz

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2. Helmholtz-Zentrum Geesthacht, Zentrum für Material- und Küstenforschung GmbH, Institute of Polymer Research, Max-Planck-Straße 1, 21502 Geesthacht, Germany

Interests: self-assembly; block copolymers; polymer blends; nanocomposites; supramolecular polymers; membranes; controlled polymerisations

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(/journal/polymers/special_issues/blo_copoly_crystal)



Prof. Dr. Haim Abramovich

Website (<http://aerospace.technion.ac.il/person/abramovich-haim/>) **SciProfiles** (<https://sciprofiles.com/profile/454767>)

Technion - Israel Institute of Technology, Faculty of Aerospace Engineering, Haifa, Israel

Interests: static and dynamic stability of thin walled structures; piezoelectric materials; laminated composite structures; dynamic buckling of thin walled structures; multifunctional materials; technologies and structures; smart structures technologies; structural mechanics and energy harvesting using piezoelectric and pyroelectric materials

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Piezoelectric Materials and Devices** (/journal/materials/special_issues/piezoelectric_devices)

Special Issue in **Aerospace: Structural Stability of Aerospace Structures** (/journal/aerospace/special_issues/strut_stab_aero_struct)

Special Issue in **Sensors: Sensors Based on Piezoelectric Materials** (/journal/sensors/special_issues/sbpm)

Special Issue in **Actuators: Piezoelectric and Electrostrictive Materials in Mechatronics, Precision Engineering and Vibration Control** (/journal/actuators/special_issues/piezoelectric_and_electrostrictive)

Special Issue in **Materials: Characteristics and Properties of Piezoelectric Smart Materials** (/journal/materials/special_issues/Piezoelectric_Smart_Materials)

Special Issue in **Materials: Large Deflections of Thin-Walled Structures** (/journal/materials/special_issues/Thin_Walled_Structures)



Dr. Renata Adami

Website (<https://www.unisa.it/docenti/radami@unisa.it/didattica>) **SciProfiles** (<https://sciprofiles.com/profile/261294>)

Departement of Industrial Engineering, University of Salerno, via Giovanni Paolo II, 132, 84084 Fisciano (SA), Italy

Interests: chemical engineering; chemical processes; nanotechnology; nano- and micro-particles; microspheres; microcapsules; controlled release; extraction and fractionation; supercritical fluids; pharmaceutical; nutraceuticals; natural science; biomedical; chromatography; spectroscopy; scanning electron microscopy; laser technology



Dr. Sergio Adamo

Website (<https://gomppublic.uniroma1.it/Docenti/Render.aspx?UID=743587a0-70bb-4278-8730-37beb875b80c>)

Histology and Medical Embryology, "Sapienza" University of Rome School of Pharmacy and Medicine Section of Histology & Medical Embryology, Department AHFOS, via A. Scarpa 16, 00161 Rome, Italy

Interests: muscle differentiation; muscle homeostasis; hormonal signaling; signal transduction



Prof. Dr. Grażyna Adamus

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

SciProfiles (<https://sciprofiles.com/profile/486243>)

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

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Special Issue in **[Polymers: Polymer Mass Spectrometry](#)** ([/journal/polymers/special_issues/Polymer_Mass_Spectrometry](#))

Special Issue in **[Polymers: Biodegradable Polymers - Where We Are and Where to Going](#)** ([/journal/polymers/special_issues/Biodegrad_Polym](#))

Special Issue in **[Biomolecules: Biodegradable Polyesters: From Synthesis to Application](#)**

([/journal/biomolecules/special_issues/Bio_degradable_Polyesters](#))

Topics: **[Advanced Polymer Materials for Sustainable Development and Health Care](#)** ([/topics/polymer_materials_sustainable](#))



Prof. Dr. Saverio Affatato

Website (<http://www.ior.it/laboratori/lab-di-tecnologia-medica/laboratorio-di-tecnologia-medica>)

SciProfiles (<https://sciprofiles.com/profile/229364>)

Laboratorio di Tecnologia Medica, IRCCS – Istituto Ortopedico Rizzoli, Via di Barbiano 1/10, 40136 Bologna, Italy

Interests: biotribology; ceramic; metal; composite; biomaterials; hip; knee; simulator; in silico; prosthesis

Special Issues, Collections and Topics in MDPI journals

Special Issue in **[Materials: Corrosion and Tribology of Biomaterials Used in Hip and Knee Arthroplasty](#)**

([/journal/materials/special_issues/Corrosion_Tribology](#))

Special Issue in **[Materials: Advanced Biomaterials for Orthopaedic Application: The Challenge of New Composites and Alloys Used as Medical Devices](#)** ([/journal/materials/special_issues/Orthopaedic_Devices](#))

Special Issue in **[Materials: Metal and Ceramics Composite Materials for Prosthetic Hip and Knee Joint Replacement](#)**

([/journal/materials/special_issues/metal_ceramics_joint-replcaement](#))

Special Issue in **[Materials: Biomaterials Used in Clinical Practice and Their Tribological Behaviours Assessed In Vitro, In Silico, and In Vivo](#)**

([/journal/materials/special_issues/biomaterials_clinical_practice](#))

Special Issue in **[Materials: Novel Ceramic Composite Biomaterials Used in the Orthopedic Field and Interest of the National Registers in Total Joint Arthroplasties](#)** ([/journal/materials/special_issues/Novel_Ceramic_Composite_Biomaterials_Used_Orthopedic_Field](#))



Dr. Stefano Agnoli

Website (<http://www.disc.chimica.unipd.it/surfacescience/>) **SciProfiles** (<https://sciprofiles.com/profile/376862>)

Department Chemistry Science, University of Padua, Via Marzolo 1, I-35131 Padua, Italy

Interests: 2D materials; transition metal dichalcogenides; electronic properties; heterogeneous catalysis; metal organic frameworks; electrocatalysis; green chemistry, metal organic frameworks, electrocatalysis, green chemistry

Special Issues, Collections and Topics in MDPI journals

Special Issue in **[Nanomaterials: Synthesis, Structure and Applications of 2D Nanomaterials](#)**

([/journal/nanomaterials/special_issues/2D_nanomater_synth_struct_appl](#))

Special Issue in **[Solids: Exclusive Papers of the Editorial Board Members \(EBMs\) of Solids](#)** ([/journal/solids/special_issues/Solids_EBMs](#))

Special Issue in **[Surfaces: Chemistry at Surfaces: Key Aspects in Materials Design and Catalysis](#)**

([/journal/surfaces/special_issues/chemistry_surfaces_materials_design_catalysis](#))



Dr. Igor Agranovski

Website (<https://experts.griffith.edu.au/18731-igor-agranovski/grants>) **SciProfiles** (<https://sciprofiles.com/profile/697362>)

School of Engineering, Griffith University, Brisbane, Australia

Interests: aerosol mechanics and nanotechnology; air pollution control and monitoring; monitoring and control of viable and non-viable airborne microorganisms (bioaerosols); filtration of liquid particles and high-temperature filtration; removal of solid particles on irrigated filters; fluid dynamics, heat and mass exchange processes, evaporation and absorption processes

Prof. Dr. Dinesh Agrawal

Website1 (<https://www.mri.psu.edu/agrawal-dinesh>) **Website2** (<https://www.mri.psu.edu/agrawal-group/personnel>)

Engineering Science and Mechanics, Pennsylvania State University, University Park, TX, USA

Interests: microwave processing of ceramics; composites; metals; low-thermal-expansion materials; ceramic processing; rad-waste management

Special Issues, Collections and Topics in MDPI journals

Special Issue in **[Materials: Microwave Processing of Materials](#)** ([/journal/materials/special_issues/microwave_process](#))

Special Issue in **[Materials: Microwave Materials Processing](#)** ([/journal/materials/special_issues/Microwave_Materials_Processing](#))

Special Issue in **[Materials: Conventional and Microwave Sintering Techniques in Materials](#)**

([/journal/materials/special_issues/Microwave_Sintering_Techniques](#))

Special Issue in **[Materials: Microwave Processing Technology for a Variety of Materials](#)**

([/journal/materials/special_issues/microwave_process_tech](#))



Prof. Dr. Francisco Agrela

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Website (<https://www.uco.es/organiza/departamentos/ing-rural/agrela-sainz-francisco.html>) **SciProfiles** (<https://sciprofiles.com/profile/74223>)

Departamento de Ingeniería Rural, Universidad de Córdoba, 14071 Córdoba, Spain

Interests: sustainable construction; recycled materials; life cycle assessment; waste and byproduct application; recycled aggregate cement-based materials

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Recycled Concrete with Waste and By-Products** (/journal/materials/special_issues/recycl_concr_waste_by-prod)

Special Issue in **Applied Sciences: Application of Biomass Ashes in Cement-Based Materials**

(/journal/applsci/special_issues/Application_Biomass_Ashes_Cement_Based_Materials)

Special Issue in **Materials: Properties and Novel Applications of Recycled Concrete and Mixed Aggregates**

(/journal/materials/special_issues/Recycled_Concrete_Aggregates)



Dr. Antonio Agresti

Website (<http://directory.uniroma2.it/index.php/chart/dettaglioDocente/12256>)

Department of Electronic Engineering, University of Roma Tor Vergata, 00133 Rome, Italy

Interests: the design, engineering, fabrication and electrical/spectroscopic characterization of hybrid and organic solar cells and large area modules; the use of graphene, transition metal dichalcogenides and new bi-dimensional materials such as MXenes for photovoltaics engineering and in particular for perovskite solar cells, tandem devices, large area modules, and panels

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Interface Engineering in Organic/Inorganic Hybrid Solar Cells** (/journal/materials/special_issues/Interface_Solar_Cell)

Special Issue in **Energies: Perovskite Photovoltaics: Strategies to Scale up Lab Cells to Modules and Panels**

(/journal/energies/special_issues/Perovskite_Photovoltaics)

Special Issue in **Materials: Two-Dimensional Materials in Solar Cells** (/journal/materials/special_issues/two_dimensional_materials_solar_cells)



Prof. Dr. Iskander Akhatov

Website1 (<https://faculty.skoltech.ru/people/iskanderakhatov>) **Website2** (<https://btl.smtu.ru/en/>)

SciProfiles (<https://sciprofiles.com/profile/1197571>)

Center for Design, Manufacturing & Materials (CDMM), Skolkovo Institute of Science & Technology, 121205 Moscow, Russia

Interests: multiphase and multiscale fluid dynamics; mathematical modeling; materials engineering; additive manufacturing; functional coatings; composite materials; materials structure and mechanical properties; atomistic modeling

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Materials Technologies: Additive Manufacturing and Functional Coatings**

(/journal/materials/special_issues/BTLA_2021_conference)

Prof. Dr. Mikko Alava

Website (<https://www.aalto.fi/en/people/mikko-alava>) **SciProfiles** (<https://sciprofiles.com/profile/1277966>)

NOMATEN Center of Excellence, NCBJ, Poland and Department of Applied Physics, Aalto University, P.O. Box 11100, FIN-00076 Aalto, Espoo, Finland

Interests: statistical physics; multiscale modelling; fracture; plasticity; bio-based materials



Dr. Radu Albuлесcu

Website (http://cfarm.ncpri.ro/sct_1/page_16/organizare.htm)

Pharmaceutical Biotechnology, National Institute for Chemical Pharmaceutical R&D, 112 Calea Vitan, 031299 Bucharest, Romania

Interests: pharmacology; proteomics; polymeric materials

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Coatings: Biological Testing of Bioceramics for Orthopedic and Dentistry Applications**

(/journal/coatings/special_issues/biological_orthopedic_dentistry)



Prof. Dr. Ricardo Alcántara



Website (<http://www.uco.es/qieiq/index.php/miembros/31-quimica-inorganica/40-ricardo-alcantara-roman>)

Department of Inorganic Chemistry and Chemical Engineering, University Institute for Research in Fine Chemistry and Nanochemistry IUIQFN, University of Córdoba, Rabanales Campus, Marie Curie Building, E-14071 Córdoba, Spain

Interests: energy storage; electrode materials; post-lithium batteries

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Advanced Electrode Materials for Batteries** (/journal/materials/special_issues/Electrode_Materials_Batteries_Energy)

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Prof. Dr. Marco Alfano

Website (<https://uwaterloo.ca/mechanical-mechatronics-engineering/>) **SciProfiles** (<https://sciprofiles.com/profile/546278>)

Department of Mechanical and Mechatronics Engineering University of Waterloo, Waterloo, ON N2L 3G1, Canada

Interests: adhesive bonding; surface pre-treatments; interface modeling & identification; architected materials and interfaces

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Adhesive Bonding Lightweight Materials in Modern Vehicles Construction**

(/journal/materials/special_issues/Adhesive_Evaluation)



Dr. Michela Alfè

Website (<http://www.irc.cnr.it/institute/alfe-michela>) **SciProfiles** (<https://sciprofiles.com/profile/772121>)

Institute for Research on Combustion (IRC-CNR), National Research Council of Italy, Piazzale V. Tecchio 80, 80125 Napoli, Italy

Interests: photocatalytic materials; carbon-based hybrid nanostructures; metal-organic frameworks; end-of-life materials valorization; graphene-related materials

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Catalysts: TiO₂-Based Nanostructures and Photocatalysts**

([/journal/catalysts/special_issues/TiO₂_Nanostructures_Photocatalysts](/journal/catalysts/special_issues/TiO2_Nanostructures_Photocatalysts))

Dr. Miguel Algueró

Website (<https://wp.icmm.csic.es/eosmad/>)

Instituto de Ciencia de Materiales de Madrid (ICMM), CSIC, Cantoblanco, 28049 Madrid, Spain

Interests: multiferroic and ferroelectric materials for information technologies, covering all single-phase and composites, ceramics and thin films, processing and properties; mechanosynthesis, sol-gel, templated grain growth, spark plasma sintering, of electrical, mechanical, electromechanical and magnetoelectric properties, nanostructuring and size effects in the nanoscale

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Advances in Magnetoelectric Composites** (/journal/materials/special_issues/magnetoelectric)



Prof. Dr. Javadi Aliyar

Website (https://tu-dresden.de/ing/maschinenwesen/ifvu/tpg/die-professur/beschaefigte/Aliyar_Javadi)

1. Institute of Fluid Dynamics, Helmholtz-Zentrum, Dresden-Rossendorf (HZDR), Bautzner Landstrasse 400, 01328 Dresden, Germany;

2. Institute of Process Engineering and Environmental Technology, Faculty of Mechanical Science and Engineering, TU-Dresden, Dresden, Germany

Interests: soft matters; bio-interfaces; self-assembly and nano structures; surfactants; proteins, polymers; bacteria and nanoparticles; foams and emulsions; complex adsorbed layers; interfacial transport phenomena in multiphase systems



Prof. Dr. Karim Allaf

Website (<https://lasie.univ-larochelle.fr/Laboratoire-des-Sciences-de-l-Ingenieur-pour-l-Environnement>)

SciProfiles (<https://sciprofiles.com/profile/560506>)

LMTA; LaSIE, UMR 7356 CNRS; La Rochelle University Avenue Michel Crepeau, 17042 La Rochelle, France

Interests: thermodynamics: transformations under extreme conditions; modeling of transfer phenomena; intensification of unit operations; instant controlled pressure-drop DIC; microbiological decontamination (vegetative and spore forms); deallergenation; intensification of Industrial processes and unit operations for highly performant industrial operations (energy consumption, environmental impact, kinetics) and high-quality attributes of the final product: drying, extraction, thermochemical transformations; biofuels: biodiesel by in situ transesterification of microalgae and oilseeds (camelina...), depolymerization and thermochemical hydrolysis of cellulosic agro-resources

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Foods: Essential Oils: Recent Advances in Extraction Processes, Fundamental Modeling, Chemical Analysis, and Applications** (/journal/foods/special_issues/Essential_Oils_Extraction_Modeling_Analysis_Applications)

Special Issue in **Molecules: Opportunities and Challenges in High Pressure Processing of Foods** (/journal/molecules/special_issues/HHP_foods)



Dr. László Almásy

Website (<https://www.szfi.hu/~almasy/>) **SciProfiles** (<https://sciprofiles.com/profile/129861>)

Centre for Energy Research, Budapest, Hungary

Interests: nanocomposites; neutron scattering; small angle scattering; nanoparticle; ferrofluid



Prof. Dr. Jose Antonio Alonso

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Website (<http://www.icmm.csic.es/matfuelcells/>) **SciProfiles** (<https://sciprofiles.com/profile/192373>)

Instituto de Ciencia de Materiales de Madrid, CSIC, Cantoblanco, 28049 Madrid, Spain

Interests: perovskite oxides; high-pressure chemistry; soft chemistry; energy conversion; magnetic oxides; solid-oxide fuel cells; thermoelectric materials; metal chalcogenides; crystal and magnetic structures; neutron diffraction



Dr. María del Mar Alonso López

Website (<https://www.ietcc.csic.es/en/general-information/directory/>) **SciProfiles** (<https://sciprofiles.com/profile/1197073>)

Department of Materials, Eduardo Torroja Institute for Construction Sciences (IETcc-CSIC), 28033 Madrid, Spain

Interests: cements; green concrete; sustainability; alkali activated materials; rheology; radioactivity

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Advances in Cement-Based Materials: Mechanical Behavior, Rheology, and Radiology**

(/journal/materials/special_issues/Cement_Materials_Mech_Rheo_Radiology)



Dr. Zeynep Altintas

Website (https://www.chemie.tu-berlin.de/dr_zeynep_altintas/home/) **SciProfiles** (<https://sciprofiles.com/profile/388060>)

Institute of Chemistry, Technische Universität Berlin, 10623 Berlin, Germany

Interests: diagnostics; micro-fluidics and lab-on-a-chip devices; sensor applications in medical diagnosis, chemistry, food safety and biotechnology; nanomaterials in health care diagnostics

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Nanomaterials in Health Care Diagnostics**

(/journal/materials/special_issues/nanomaterials_in_health_care_diagnostics)

Special Issue in **Micromachines: Biosensors and MEMS-based Diagnostic Applications**

(/journal/micromachines/special_issues/Biosensors_MEMS_Diagnostic_Applications)

Special Issue in **Micromachines: Biosensors and MEMS-based Diagnostic Applications, Volume II**

(/journal/micromachines/special_issues/biosensors_MEMS_diagnostic_applications_volume_II)

Special Issue in **Biosensors: Biosensors in 2022** (/journal/biosensors/special_issues/Biosensors_2022)



Dr. Ulises Julio Amador Elizondo

Website (<http://ww2.uspceu.es/aplpro/pg/verpg.aspx?cip=NTAxNTYwOTE=>) **SciProfiles** (<https://sciprofiles.com/profile/1300493>)

Departamento de Química y Bioquímica, Facultad de Farmacia, Universidad San Pablo-CEU, Urbanización Montepríncipe, Boadilla del Monte, 28668 Madrid, Spain

Interests: materials science; multidisciplinary; chemistry; crystallography; electrochemistry; energy and fuels; physics

Dr. Sima Aminorroaya Yamini

Website (<https://www.shu.ac.uk/about-us/our-people/staff-profiles/sima-aminorroaya-yamini>)

SciProfiles (<https://sciprofiles.com/profile/698825>)

Department of Engineering and Mathematics, Sheffield Hallam University, Sheffield S1 1 WB, UK

Interests: design, fabrication, and characterisation of functional materials for advanced manufacturing applications

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Functional Materials for Energy Conversion and Storage**

(/journal/materials/special_issues/funct_mater_energy_convers_storage)



Prof. Dr. Ben Amor

Website (<https://www.usherbrooke.ca/gcivil/departement/corps-professoral/mourad-ben-amor/>)

SciProfiles (<https://sciprofiles.com/profile/271840>)

LIRIDE (Interdisciplinary Research Laboratory on Sustainable Engineering and Ecodesign), Civil and Building Engineering Department, University of Sherbrooke, Sherbrooke, QC J1K 2R1, Canada

Interests: life cycle assessment; circular economy; materials flow analysis; green Buildings; eco-materials

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Sustainability: Future-Oriented LCA: Current Practice, Emerging Topics and Innovative Approaches**

(/journal/sustainability/special_issues/future-oriented_LCA_current_practice_emerging_topics_innovative_approaches)



Prof. Dr. Linan An

Website (<https://www.cecs.ucf.edu/faculty/linan-an/>)

Department of Materials Science and Engineering, University of Central Florida, Orlando, FL 32816, USA

Interests: ceramics; composites; mechanical behavior; advanced processing



Dr. Qi An

Website (<https://www.unr.edu/cme/people/qi-an>)

Department of Chemical and Materials Engineering, University of Nevada-Reno, Reno, NV 89557, USA

Interests: density functional theory; molecular dynamics; mechanical behavior; heterogeneous catalysis

Dr. Jānis Andersons

Website1 (https://www.researchgate.net/profile/Jnis_Andersons) **Website2** (<https://publons.com/researcher/2890516/janis-andersons/>)

SciProfiles (<https://sciprofiles.com/profile/865734>)

Institute for Mechanics of Materials, University of Latvia, Riga, Latvia

Interests: polymer composites; cellular and porous materials; durability of polymer composites; deformation and fracture mechanics of composites; natural fibers

Prof. Dr. Christos G. Aneziris

Website (<https://tu-freiberg.de/en/ikfvw/ceramic/prof-dr-ing-habil-christos-g-aneziris>) **SciProfiles** (<https://sciprofiles.com/profile/1303805>)

Institute of Ceramics, Refractories and Composite Materials, Technische Universität Bergakademie Freiberg, 09599 Freiberg, Germany

Interests: refractories; coarse grained metal/ceramic composites; refractory composites; porous ceramics; porous metal/ceramic composites



Prof. Dr. Marco Annunziata

Website (<https://www.dipmdsmco.unicampania.it/dipartimento/docenti?MATRICOLA=059384>)

Multidisciplinary Department of Medical-Surgical and Dental Specialties, University of Campania "Luigi Vanvitelli", 80138 Naples, Italy

Interests: periodontal diseases; implant dentistry; peri-implant diseases

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Biomaterials and Biological Mediators for Periodontal and Bone Regeneration**

(/journal/materials/special_issues/Biomaterials-Biological-Mediators)

Special Issue in **Pathogens: Biomarkers in Oral Diseases** (/journal/pathogens/special_issues/biomarkers_oral_diseases)

Special Issue in **Biomolecules: Biomarkers in Oral Diseases** (/journal/biomolecules/special_issues/biomarkers_in_oral_diseases)



Dr. Roman Perez Antoñanzas

Website (<http://www.uic.es/en/bit>) **SciProfiles** (<https://sciprofiles.com/profile/534645>)

Bioengineering Institute of Technology, Universitat Internacional de Catalunya, C/ Immaculada, 22 08017 Barcelona, Spain

Interests: biomaterials; tissue engineering; bioactive ceramics; drug delivery; cell delivery; functionalization; bone regeneration

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Coatings: Bioactive Surfaces and Coatings for Bone Regeneration**

(/journal/coatings/special_issues/bioactive_surf_coat_bone_regeneration)

Special Issue in **Materials: Biofunctionalization of Metallic Biomaterials** (/journal/materials/special_issues/biofunction_metal_biomater)

Special Issue in **Coatings: Recent Advanced in Titanium-Based Coatings** (/journal/coatings/special_issues/Recent_Adv_Titan_Based_Coat)



Prof. Dr. Iulian Vasile Antoniac

Website (<https://antoniaciulian.ro/>) **SciProfiles** (<https://sciprofiles.com/profile/439598>)

Faculty of Material Science and Engineering, University Politehnica of Bucharest, 313 Splaiul Independentei Street, District 6, 060042 Bucharest, Romania

Interests: biodegradable metallic biomaterials; medical devices; surface modification; interaction tissue-biomaterials; bioceramics; biocomposites; biointerfaces; tissue engineering; bone regeneration; retrieval and failure analysis of orthopedic and dental implants

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Selected Papers from BIOMMEDD 2018 Conference—Biomaterials** (/journal/materials/special_issues/biommedd_2018/)

Special Issue in **Materials: Biomaterials Performance in Clinical Cases and Failure Analysis of Implants** (/journal/materials/special_issues/bpcccfai/)

Special Issue in **Materials: Dental Biomaterials 2020** (/journal/materials/special_issues/DB20/)

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Special Issue in **Metals: Processing, Characterization and Testing of Alloys and Metal Matrix Composites for Biomedical Applications** (/journal/metals/special_issues/Biomedical_alloys_composites/)

Special Issue in **Materials: State-of-the-Art Materials Science and Engineering in Romania 2022** (/journal/materials/special_issues/Romania_2022/)

Topics: **Materials in Implant Applications and Regenerative Medicine** (/topics/implant_regenerative_materials/)



Prof. Dr. Irina V. Antonova

Website (<https://www.isp.nsc.ru/en/institute/institute-divisions/laboratory-of-three-dimensional-nanostructures/staff-members/irina-v-antonova/>)

Institute of Semiconductor Physics, Siberian Branch, Russian Academy of Sciences, 630090 Novosibirsk, Russia

Interests: graphene; derivatives; heterostructures; electronics devices; memristors; sensors

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Graphene and 2D Materials for Flexible Electronics** (/journal/materials/special_issues/2D_flexible_electronics/)

Special Issue in **Nanomaterials: Electronic Applications of Graphene-Based Composites** (/journal/nanomaterials/special_issues/graphene_composite/)



Prof. Dr. PierLuigi Antonucci

Website (https://www.unirc.it/scheda_persona.php?id=18)

Civil Engineering, Energy, Environmental and Materials Department, University Mediterranea of Reggio Calabria, 89134 Reggio Calabria, Italy

Interests: energy materials; advanced nanomaterials and nanotechnology; catalytic materials; carbon materials



Dr. Giovanni Battista Appetecchi

Website (<https://materiali.sostenibilita.enea.it/people/giovanni-battista-appetecchi>)

ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development), Department for Sustainability (SSPT), Division for Sustainable Materials (PROMAS), Materials and Physicochemical Processes Laboratory (MATPRO), Casaccia Research Center, Via Anguillarese 301, 00123 Rome, Italy

Interests: research and development of electrolyte/electrode materials/components for electrochemical energy storage systems; ionic liquids; polymer and gel electrolytes; lithium batteries

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Membranes: Membranes for Lithium Batteries** (/journal/membranes/special_issues/lithium_batteries/)

Special Issue in **Membranes: Composite Electrolyte & Electrode Membranes for Electrochemical Energy Storage & Conversion Devices** (/journal/membranes/special_issues/electrochemical_energy/)

Special Issue in **Materials: The Wonderful World of Ionic Liquids and Deep Eutectic Solvents** (/journal/materials/special_issues/Ionic_Liquid_Properties_Synthesis/)



Prof. Dr. Miguel A. G. Aranda

Website (<https://sites.google.com/view/miguel-ag-aranda/>) **SciProfiles** (<https://sciprofiles.com/profile/316237>)

1. Department of Inorganic Chemistry, University of Málaga, Leon Tolstoi Street, 29010 Málaga, Spain

2. ALBA Synchrotron Collaborator, Carrer de la Lum, 2-26, 08290 Cerdanyola del Vallès, Barcelona, Spain

Interests: eco-cements; industrially-relevant materials (pigments, ceramics, etc.); synchrotron powder diffraction; high pressure diffraction; X-ray pair distribution function; coherent diffraction imaging;ptychographic X-ray computed nanotomography; microstructure; multiscale characterization



Prof. Dr. Carla Renata Arciola

Website (<http://www.ior.it/ricerca-e-innovazione/Prof.ssa%20Carla%20Renata%20Arciola>) **SciProfiles** (<https://sciprofiles.com/profile/1570940>)

1. Head of the Research Unit on Implant Infections, Rizzoli Orthopaedic Institute, Via di Barbiano 1/10, 40136 Bologna, Italy

2. Professor of General Pathology, Medical School, University of Bologna, Via S. Giacomo 14, 40126 Bologna, Italy

Interests: anti-adhesive surfaces; anti-biofilm agents; anti-biofouling materials; antibiotic-loaded biomaterials; anti-infective materials; anti-infective tissue regeneration membranes; bioactive antibacterial coatings; materials delivering antimicrobials; covalent conjugation of antimicrobial peptides; (GTR/GBR)

membrane with anti-infective properties; implant infections; multilayer antibacterial films; periprosthetic infections; photocatalytic coatings for hygienic surfaces; technologies and nano-technologies for infection-resistant surfaces

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Anti-Infective Materials in Medicine and Technology** (/journal/materials/special_issues/Anti-Infective)

Special Issue in **Materials: State-of-the-Art Materials Science in Italy 2017** (/journal/materials/special_issues/Italy_17)



Dr. Ana Arenillas

Website (http://www.incar.csic.es/aapunte_cv) **SciProfiles** (<https://sciprofiles.com/profile/144984>)

CSIC - Instituto Nacional del Carbón (INCAR), Oviedo, Spain

Interests: carbon gels; polymer design; energy; microwave heating

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Materials: Organic and Carbon Gels: Properties and Application** (/journal/materials/special_issues/carbon_gels)



Prof. Dr. José Ramón Ares Fernández

Website ([http://www.uam.es/ss/Satellite?](http://www.uam.es/ss/Satellite?c=EPS_Persona_FA&cid=1446761284999&language=es&pagename=FacdCiencias%2FEPS_Persona_FA%2FFAC_detallePDI&pid=14467615327)

[c=EPS_Persona_FA&cid=1446761284999&language=es&pagename=FacdCiencias%2FEPS_Persona_FA%2FFAC_detallePDI&pid=14467615327](http://www.uam.es/ss/Satellite?c=EPS_Persona_FA&cid=1446761284999&language=es&pagename=FacdCiencias%2FEPS_Persona_FA%2FFAC_detallePDI&pid=14467615327)

Departamento de Física de Materiales, Universidad Autónoma de Madrid, 28049 Madrid, Spain

Interests: synthesis and characterization of novel materials for energy conversion and storage; hydrides and sulfides; hydrogen storage; thermoelectricity



Prof. Dr. Dimitris S. Argyropoulos

Website (<http://www4.ncsu.edu/~dsargyro>) **SciProfiles** (<https://sciprofiles.com/profile/49991>)

Departments of Forest Biomaterials & Chemistry, North Carolina State University, 2820 Faucette Drive, Rm 3104, Raleigh, NC 27695-8005, USA

Interests: materials; chemicals and energy from forest biomass; organic chemistry of wood components; bio-refining of lignin; cellulose and nano-cellulose based smart materials; NMR spectroscopy and polymer chemistry of biopolymers

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Energies: Wood to Energy** (/journal/energies/special_issues/wood_to_energy)

Special Issue in **Energies: Advances and Challenges in Cellulosic Ethanol** (/journal/energies/special_issues/cellulosic_ethanol)

Special Issue in **Energies: Energy from Forest Biomass** (/journal/energies/special_issues/forest_biomass)



Prof. Dr. Katsuhiko Ariga

★ (<https://recognition.webofsciencegroup.com/awards/highly-cited/2020/>) **Website** (https://en.wikipedia.org/wiki/Katsuhiko_Ariga)

World Premier International Research Center for Materials Nanoarchitectonics (WPI-MANA), National Institute for Materials Science (NIMS), 1-1, Namiki, Tsukuba, Ibaraki 305-0044, Japan

Interests: nanoarchitectonics; supramolecular chemistry; interface science

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Special Issue in **Materials: Nanoarchitectonics: A New Paradigm for Materials Science with Nanotechnology** (/journal/materials/special_issues/nanoarchitectonics)

Special Issue in **Crystals: Nanoarchitectonics for Supramolecular Crystals and Assemblies** (/journal/crystals/special_issues/Nanoarchitectonics_Crystals)

Topics: **Nanoarchitectonics with Molecular and Materials Science: Functional Materials for Energy, Environment, Bio and Others** (</topics/nanoarchitectonics>)



Prof. Dr. Elaine Armelin

Website (<https://futur.upc.edu/ElaineArmelinDiggroc>) **SciProfiles** (<https://sciprofiles.com/profile/304679>)

Chemical Engineering Department, Universitat Politècnica de Catalunya, Av. Eduard Maristany, 10-14, I2.2, Barcelona, Spain

Interests: Biomaterials; conducting polymers; hybrid materials; multifunctional coatings; plasma-polymers; thin films; corrosion wear

Dr. Ilaria Armentano

Website (<http://www.ing1.unipg.it/ricerca/gruppi-di-ricerca/gruppo-di-ricerca-di-scienza-e-tecnologia-dei-materiali/ilaria-armentano>)

SciProfiles (<https://sciprofiles.com/profile/479040>)

Materials Engineering Centre, UdR INSTM, NIPLAB, University of Perugia, 4 - 05100 Terni, Italy

Special Issues, Collections and Topics in MDPI journals

Special Issue in [MDPI](#) **Nanomaterials: Nanomaterials for Tissue Engineering** ([/journal/nanomaterials/special_issues/nano_tissue_eng](#))

Special Issue in **Nanomaterials: Nanocomposites Based on Biodegradable Polymers for Tissue Engineering Applications** ([/journal/nanomaterials/special_issues/biodegradable_nano_tissue_engineering](#))

Special Issue in **Journal of Composites Science: Carbon-Based Polymer Nanocomposites** ([/journal/jcs/special_issues/Carbon_Polymer_Nanocomposites](#))

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Prof. Dr. Dwayne D. Arola

Website (<https://mse.washington.edu/facultyfinder/dwayne-d-arola>)

Materials Science and Engineering, University of Washington, Seattle, WA 98195, USA

Interests: bioinspiration; durability; fatigue; fracture toughness; natural armors



Dr. Manuel Arruebo

Website (<http://iqtma.unizar.es/>)

Department of Chemical Engineering, University of Zaragoza, 50018 Zaragoza, Spain

Interests: nanoparticle synthesis; microfluidics; drug delivery; biomaterials



Dr. Cristina Artini

Website (<https://www.icmate.cnr.it/it/persona/scheda/userprofile/cristina.artini>) **SciProfiles** (<https://sciprofiles.com/profile/561941>)

Department of Chemistry and Industrial Chemistry, University of Genova, 16146 Genova, Italy;

CNR-ICMATE, Genova Research Unit, 16149 Genova, Italy

Interests: solid oxide cells; ionic conductors; doped ceria; thermoelectric materials; skutterudites; powder x-ray diffraction; Raman spectroscopy

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Inorganics: Rare Earth-Doped Ceria Systems and Their Applications**

([/journal/inorganics/special_issues/Rare_Earth_Doped_Ceria](#))

Prof. Dr. Maria C. Asensio

Website (https://www.synchrotron-soleil.fr/sites/default/files/mc_asensio.pdf) **SciProfiles** (<https://sciprofiles.com/profile/170908>)

Materials Science Institute of Madrid (ICMM), Spanish Scientific Research Council (CSIC), 328049 Madrid, Spain

Interests: electronic structure; synchrotron radiation techniques; ARPES; graphene; silicene; nanoARPES; XAS; x-ray absorption microscopy; photoemission microscopy; chemical imaging



Dr. Aymen Amine Assadi

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Laboratory "Sciences Chimiques de Rennes"— Team "Chimie et Ingénierie des Procédés", 11 allée de Beaulieu, CS 50837, 35708 Rennes, CEDEX 7, France

Interests: chemical and environmental engineering; process intensification; photocatalysis

Special Issues, Collections and Topics in MDPI journals

Special Issue in **Catalysts: Photocatalysis and Environment** ([/journal/catalysts/special_issues/photocatalysis_environment](#))

Special Issue in **Materials: Advanced Materials and Photoreactors for Environmental Applications**

([/journal/materials/special_issues/photoreactors_environmental_applications](#))



Prof. Dr. Andrej Atrens

Website (<https://researchers.uq.edu.au/researcher/141>)

Emeritus Professor, School of Mechanical and Mining Engineering, Faculty of Engineering, Architecture and Information Technology, The University of Queensland, Brisbane, Australia

Interests: Mg Corrosion; hydrogen embrittlement, stress corrosion cracking

Prof. Dr. David Atwood

Website (<https://chem.as.uky.edu/users/datwood>)

Department of Chemistry, University of Kentucky, Lexington, KY 40506, USA

Interests: inorganic and materials chemistry; organic and organometallic chemistry; biological and pharmaceutical chemistry



Prof. Dr. Matthias Auf der Maur

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[Website \(http://www.optolab.uniroma2.it/team/staff/67-matthias-auf-der-maur.html\)](http://www.optolab.uniroma2.it/team/staff/67-matthias-auf-der-maur.html) [SciProfiles \(https://sciprofiles.com/profile/1640334\)](https://sciprofiles.com/profile/1640334)

Department of Electronic Engineering, Università degli Studi di Roma Tor Vergata, Rome, Italy

Interests: device simulation from atomistic scale to continuum; III-nitrides; metal-halide perovskites; solar cells; light emitting devices; optical modelling



Prof. Dr. Massimiliano Avalle

[Website \(https://rubrica.unige.it/personale/UkJHWVts\)](https://rubrica.unige.it/personale/UkJHWVts)

DIME—Department of Mechanical, Energy, Management and Transportation Engineering Polytechnic School, University of Genoa, 16145 Genoa, Italy

Interests: materials characterization and modeling; design and optimization of AM structures; cellular materials

Special Issues, Collections and Topics in MDPI journals

Special Issue in [Materials: Additive Manufacturing Methods and Modeling Approaches \(/journal/materials/special_issues/Additive_Approaches\)](#)

Special Issue in [Materials: Innovation in Joining and Welding Processes \(/journal/materials/special_issues/joining_and_welding_process\)](#)

Special Issue in [Materials: Additive Manufacturing Methods and Modeling Approaches \(Volume II\)](#)

[\(/journal/materials/special_issues/Additive_Modeling_II\)](#)



Prof. Dr. Luc Avérous

[Website \(https://www.biodeg.net/\)](https://www.biodeg.net/) [SciProfiles \(https://sciprofiles.com/profile/197785\)](https://sciprofiles.com/profile/197785)

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. Ravichandar Babarao

[Website1 \(https://www.rmit.edu.au/contact/staff-contacts/academic-staff/b/babarao-dr-ravichandar\)](https://www.rmit.edu.au/contact/staff-contacts/academic-staff/b/babarao-dr-ravichandar) [Website2 \(http://rbabarao.net\)](http://rbabarao.net)

[SciProfiles \(https://sciprofiles.com/profile/2266394\)](https://sciprofiles.com/profile/2266394)

RMIT University, Melbourne, Australia

Interests: metal organic frameworks; porous materials; gas storage and separation; Monte Carlo; DFT and Molecular Dynamics



Prof. Dr. Emil Babić

[Website \(https://www.pmf.unizg.hr/phy/en/emil.babic\)](https://www.pmf.unizg.hr/phy/en/emil.babic)

Department of Physics, Faculty of Science, University of Zagreb, Zagreb, Croatia

Interests: disordered and metastable systems; nanostructured materials; electronic and magnetic properties; experimental techniques

Special Issues, Collections and Topics in MDPI journals

Special Issue in [Materials: Compositional Complex Alloys: From Amorphous to High-Entropy \(/journal/materials/special_issues/AHE\)](#)



Dr. Michele Baccocchi

[Website \(https://www.unirsm.sm/it/corso-laurea-ingegneria-civile/didattica/docenti-collaboratori/baccocchi_105_9212.htm\)](https://www.unirsm.sm/it/corso-laurea-ingegneria-civile/didattica/docenti-collaboratori/baccocchi_105_9212.htm)

[SciProfiles \(https://sciprofiles.com/profile/227520\)](https://sciprofiles.com/profile/227520)

Dipartimento di Economia, Scienze e Diritto (DESD), University of San Marino, Via Consiglio dei Sessanta, 47891 Dogana, San Marino

Interests: finite element methods; structural mechanics; plates and beams; numerical analysis; laminated composites; multiphase composites; innovative composite materials; functionally graded materials; carbon nanotubes; numerical analysis; non-local theories

Special Issues, Collections and Topics in MDPI journals

Special Issue in [Journal of Composites Science: Mechanics of Innovative Materials in Engineering Applications](#)

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Special Issue in [Materials: Advances in Structural Mechanics Modeled with FEM](#)

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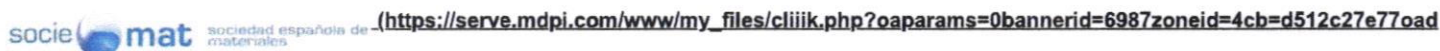
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Special Issue in [Mathematical and Computational Applications: Mathematical and Computational Approaches in Applied Mechanics: A Themed Issue Dedicated to Professor J.N. Reddy](#)

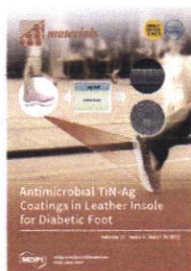
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- [Vol. 4 \(2011\) \(/1996-1944/4\)](#)
- [Vol. 3 \(2010\) \(/1996-1944/3\)](#)
- [Vol. 2 \(2009\) \(/1996-1944/2\)](#)
- [Vol. 1 \(2008\) \(/1996-1944/1\)](#)

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Materials, Volume 15, Issue 6 (March-2 2022) – 357 articles



Cover Story ([view full-size image \(/files/uploaded/covers/materials/big_cover-materials-v15-i6.png\)](#)): This work reports on TiN-Ag antimicrobial coatings deposited by DC magnetron sputtering on leather for insoles on the footwear industry and studies involving the antimicrobial properties of these coatings. The XRD results suggested the presence of a crystalline fcc-TiN phase and a fcc-Ag phase in the samples containing silver. SEM analysis shows that coatings were homogeneous, and dispersed Ag clusters were found on samples with silver content above 8 at.%. ICP-OES spectrometry analysis showed that the ionization of silver over time depends on the morphology of coatings. The samples did not present cytotoxicity and only samples with silver presented antibacterial and antifungal activity, highlighting the potential of the TiN-Ag insole coatings for diseases such as diabetic foot. [View this paper \(https://www.mdpi.com/1996-1944/15/6/2009\)](#)

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
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Study of Compatibility and Flame Retardancy of TPU/PLA Composites (/1996-1944/15/6/2339)

by  [Zusheng Hang \(https://sciprofiles.com/profile/897449\)](https://sciprofiles.com/profile/897449),  [Zichun Lv \(https://sciprofiles.com/profile/2076665\)](https://sciprofiles.com/profile/2076665),  [Liu Feng \(https://sciprofiles.com/profile/2076666\)](https://sciprofiles.com/profile/2076666) and  [Ben Liu \(https://sciprofiles.com/profile/2076667\)](https://sciprofiles.com/profile/2076667)

Materials **2022**, *15*(6), 2339; <https://doi.org/10.3390/ma15062339> (<https://doi.org/10.3390/ma15062339>) - 21 Mar 2022

Viewed by 377

Abstract In order to apply the rigid biodegradable PLA material for flexible toothbrush bristle products, in this paper, Poly(lactic acid) (PLA) and thermoplastic polyurethane elastomer (TPU) blends (TPU/PLA composites), with a mass ratio of 80:20, were prepared by the melt-blending method to achieve toughening [...]. [Read more.](#)

(This article belongs to the Section [Polymeric Materials \(/journal/materials/sections/polymeric_materials\)](#))

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A Numerical Analysis of Ductile Deformation during Nanocutting of Silicon Carbide via Molecular Dynamics Simulation (/1996-1944/15/6/2325)

by  [Bing Liu \(https://sciprofiles.com/profile/563885\)](https://sciprofiles.com/profile/563885),

 [Xiaolin Li \(https://sciprofiles.com/profile/author/TDIPMWOyBENUd25KV2INU0JOeGtRZHAwOC9yMEUxWXowaytnWEh5SUdSQT0=\)](https://sciprofiles.com/profile/author/TDIPMWOyBENUd25KV2INU0JOeGtRZHAwOC9yMEUxWXowaytnWEh5SUdSQT0=),

 [Ruijie Kong \(https://sciprofiles.com/profile/author/dnJQW11RjFzLy96UIFvaVVIZIVkTTZOUFB0cEs4L3rSWdpQVdVbUtzWT0=\)](https://sciprofiles.com/profile/author/dnJQW11RjFzLy96UIFvaVVIZIVkTTZOUFB0cEs4L3rSWdpQVdVbUtzWT0=),

 [Haijie Yang \(https://sciprofiles.com/profile/author/VTQ3Y2FHYkVPeTFsMkdwT2lZVnZ0VW9ER05ndVpIRW1rVDZVVW0rM0t5WT0=\)](https://sciprofiles.com/profile/author/VTQ3Y2FHYkVPeTFsMkdwT2lZVnZ0VW9ER05ndVpIRW1rVDZVVW0rM0t5WT0=) and

 [Lili Jiang \(https://sciprofiles.com/profile/563893\)](https://sciprofiles.com/profile/563893)

Materials 2022, 15(6), 2325; <https://doi.org/10.3390/ma15062325> (<https://doi.org/10.3390/ma15062325>) - 21 Mar 2022

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Abstract As a typical third-generation semiconductor material, silicon carbide (SiC) has been increasingly used in recent years. However, the outstanding performance of SiC component can only be obtained when it has a high-quality surface and low-damage subsurface. Due to the hard–brittle property of SiC, [...] [Read more.](#)

(This article belongs to the Topic **Processing, Analysis, Modelling and Mechanics of Materials and Structures** (/topics/mat_struct))

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Fabrication and Characterization of Submicron-Scale Bovine Hydroxyapatite: A Top-Down Approach for a Natural Biomaterial (/1996-1944/15/6/2324)

by  [Maria Apriliani Gani \(https://sciprofiles.com/profile/1691409\)](https://sciprofiles.com/profile/1691409),  [Aniek Setiya Budiatin \(https://sciprofiles.com/profile/1704232\)](https://sciprofiles.com/profile/1704232),

 [Maria Lucia Ardhani Dwi Lestari \(https://sciprofiles.com/profile/2057498\)](https://sciprofiles.com/profile/2057498),  [Fedik Abdul Rantam \(https://sciprofiles.com/profile/1450001\)](https://sciprofiles.com/profile/1450001),

 [Chrismawan Ardianto \(https://sciprofiles.com/profile/2036514\)](https://sciprofiles.com/profile/2036514) and  [Junaidi Khotib \(https://sciprofiles.com/profile/1612176\)](https://sciprofiles.com/profile/1612176)

Materials 2022, 15(6), 2324; <https://doi.org/10.3390/ma15062324> (<https://doi.org/10.3390/ma15062324>) - 21 Mar 2022

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Abstract Submicron hydroxyapatite has been reported to have beneficial effects in bone tissue engineering. This study aimed to fabricate submicron-scale bovine hydroxyapatite (BHA) using the high-energy dry ball milling method. Bovine cortical bone was pretreated and calcined to produce BHA powder scaled in microns. [...] [Read more.](#)

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☰ ⬇️ (/1996-1944/15/6/2323/pdf)

Suitability of Constitutive Models of the Structural Concrete Codes When Applied to Polyolefin Fibre Reinforced Concrete (/1996-1944/15/6/2323)

by  [Alejandro Enfedaque \(https://sciprofiles.com/profile/360145\)](https://sciprofiles.com/profile/360145),  [Fernando Suárez \(https://sciprofiles.com/profile/275075\)](https://sciprofiles.com/profile/275075),

 [Marcos G. Alberti \(https://sciprofiles.com/profile/612924\)](https://sciprofiles.com/profile/612924) and  [Jaime C. Gálvez \(https://sciprofiles.com/profile/139345\)](https://sciprofiles.com/profile/139345)

Materials 2022, 15(6), 2323; <https://doi.org/10.3390/ma15062323> (<https://doi.org/10.3390/ma15062323>) - 21 Mar 2022

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Article

Fabrication and Characterization of Submicron-Scale Bovine Hydroxyapatite: A Top-Down Approach for a Natural Biomaterial

Maria Apriliani Gani ¹, Aniek Setiya Budiati ², Maria Lucia Ardhani Dwi Lestari ³, Fedik Abdul Rantam ⁴,
Christmawan Ardianto ² and Junaidi Khotib ^{2,*}

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Abstract: Submicron hydroxyapatite has been reported to have beneficial effects in bone tissue engineering. This study aimed to fabricate submicron-scale bovine hydroxyapatite (BHA) using the high-energy dry ball milling method. Bovine cortical bone was pretreated and calcined to produce BHA powder scaled in microns. BHA was used to fabricate submicron BHA with milling treatment for 3, 6, and 9 h and was characterized by using dynamic light scattering, scanning electron microscope connected with energy dispersive X-Ray spectroscopy, Fourier-transform infrared spectroscopy, and X-ray diffractometry to obtain its particle size, calcium-to-phosphorus (Ca/P) ratio, functional chemical group, and XRD peaks and crystallinity. Results showed that the particle size of BHA had a wide distribution range, with peaks from ~5 to ~10 μm . Milling treatment for 3, 6, and 9 h successfully gradually reduced the particle size of BHA to a submicron scale. The milled BHA's hydrodynamic size was significantly smaller compared to unmilled BHA. Milling treatment reduced the crystallinity of BHA. However, the treatment did not affect other characteristics; unmilled and milled BHA was shaped hexagonally, had carbonate and phosphate substitution groups, and the Ca/P ratio ranged from 1.48 to 1.68. In conclusion, the fabrication of submicron-scale BHA was successfully conducted using a high-energy dry ball milling method. The milling treatment did not affect the natural characteristics of BHA. Thus, the submicron-scale BHA may be potentially useful as a biomaterial for bone grafts.

Keywords: submicron material; nanomaterial; bone scaffold; bone graft; calcium phosphate; neglected disease



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1. Introduction

Bone defects represent a neglected form of disease that may severely interfere with the physiological function of bones [1–3]. This form of disease may also affect an individual's quality of life and the patient's economic burden [1]. Every year, more than 2.2 million people globally undergo bone grafting procedures to treat bone defects [4]. Therefore, the development of osteoconductive biomaterial should focus on bone tissue engineering to accelerate bone defect repairs.

The development of nanoscale materials has been rapidly increasing in recent decades. Nanoscale biomaterials have been reported to have beneficial effects in bone tissue engineering, such as increasing the adhesion, differentiation, and proliferation of osteoblasts and providing vascularization and bone formation in vivo [5,6]. However, the effects of

nanomaterials, particularly in osteoclasts, were not as expected in osteoblasts. Chen et al. [7] reported that HA in nanoscale grain sizes (~100 nm) impaired osteoclastic formation and function. This was evidenced by inhibited cell fusion, reduced osteoclast size, increased osteoclast apoptosis, suppressed expression of osteoclast specific genes and proteins, and hampered resorption activity compared to submicron HA (~500 nm). Other than that, nanoparticles smaller than 10 nm were indicated to act similar to gas and may cross various biological barriers, reaching sensitive organs and disturbing normal cell behavior [8,9].

Furthermore, the study begins to report the beneficial effect of submicron +–scale material for bone reconstruction. The submicron +–scale material was also found to be the most influential surface dimension in promoting osteoblast differentiation, as reported by Khang et al. [10]. In addition, submicron-scale ceramic (grain size: ~800 nm) was observed to enhance bone regeneration after 12 weeks of implantation [11]. Particularly in regard to osteoclasts, it has been reported that hydroxyapatite with a particle size of ~500 nm beneficially influences osteoclast formation and function compared to smaller-sized materials [7]. Thus, considering the controversy of material sizes, it is suggested that the submicron-scale materials potentially have superior action on bone cells, particularly osteoclasts, and may be combined with other ceramics to produce desired characteristics for bone tissue regeneration [12–15].

Hydroxyapatite (HA) is a derivate of calcium phosphate that is widely used for medical purposes, including orthopedic and dental [16]. HA as a biomaterial can be synthesized from chemical precursors known as synthetic HA or extracted from natural sources such as mammalian bones [16]. One advantage in using natural HA compared to synthetic HA is the characteristics of natural HA. Natural HA, such as bovine hydroxyapatite (BHA), has a carbonate substitution group on its apatite. The natural HA is similar to human bone and was not found in synthetic HA [17–19]. Carbonated HA was found to increase osteoblast proliferation in vitro [20]. Other characteristics of BHA, such as its high compressive strength, prevent premature degradation and support bone formation in vivo [16,21].

Considering the beneficial effects of BHA and submicron material in bone tissue engineering, the development of submicron BHA potentially increases the osteoinductive and osteoconductive properties of BHA. As it was established that submicron material had a superior effect on osteoclasts [7], submicron BHA will also benefit bone diseases related to osteoclast dysfunction.

Studies have reported that critical parameters must be considered when fabricating hydroxyapatite [13,14,22,23]. Due to the high compressive strength property of BHA, an appropriate method should be chosen to reduce the particle size of the BHA. A previous study by Ruksudjarit et al. [24] synthesized a nano-hydroxyapatite using the wet ball milling method with ethanol as the milling media. Ethanol is widely used as a process control agent (PCA) in the milling process of biomaterials [25]. However, the use of ethanol and other organic solvents is known to be the most common source of contamination of obtained materials. These solvents reduced crystallinity, and also changed the morphology and distribution of elements of the starting materials [26,27]. Because of this, it is suggested that the use of organic compounds should be avoided in the milling treatment of biomaterials.

This study aimed to fabricate submicron-scale HA by using high-energy dry ball milling. In this study, bovine bones were given pretreatment (boiled, dried, and calcined) in order to obtain BHA. BHA naturally sized in microns was milled for several hours by using the high-energy dry ball milling method. Milled and unmilled BHA then were characterized by using dynamic light scattering (DLS, Beckman Coulter, Indianapolis, IN, USA), a scanning electron microscope connected with energy dispersive X-Ray spectroscopy (SEM-EDX, Carl Zeiss, Oberkochen, Germany), Fourier-transform infrared spectroscopy (FTIR, Bruker, Leipzig, Germany), and X-ray diffractometry (XRD, PANalytical Corporation, Almelo, The Netherlands). Submicron-scale BHA with innate characteristics of human bone has the potential to be used for bone grafts or drug delivery systems to bone tissues.

2. Materials and Methods

2.1. Extraction of Bovine Hydroxyapatite

BHA was extracted based on the methods used by Budiadin et al. [18], with modifications. The raw material was fresh cortical bone from mature bovines. Bone was cut and cleaned with water, and spongy parts and bone marrow were removed. Furthermore, the bone was boiled for 5 h in distilled water (distilled water was changed every hour). Bone was boiled in the pressurized tank for 3 h (water was changed every one hour). The boiled bone was then dried at 60 °C for three hours. The dried bone was soaked in absolute ethanol (Brataco Chemika, Surabaya, Indonesia) for 24 h while being shaken (ethanol was changed every 12 h). Calcination was conducted for two hours at 1000 °C. Finally, the bone was ground and sieved through an 80-mesh sieve.

This study also examined the BHA-based and HA-based scaffold's compressive strength. The scaffolds were made from extracted BHA and HA (CASs number 1306-06-5, molecular weight 1004.6 g mol⁻¹; further characteristics are present in Figure S1). Briefly, BHA or HA (10 g) was added to 5 mL of a prepared 20% gelatin solution (Cartino, Samut Prakan, Thailand). The mixture was stirred and sieved using a mesh (size: 1.0 mm) and dried at 37 °C. Next, 25 mg of granules were molded into an implant (diameter: 2 mm) using a hydraulic press (2 ton; Graseby-Specac Ltd., Orpington, Kent, London, UK).

2.2. Fabrication of Submicron-Scale BHA Using High-Energy Dry Milling

The fabrication of submicron-scale BHA was conducted based on the methods of Aminatun et al. (2019) [27]. BHA extracted from the previous method was used as the starting material. A milling ball made from alumina was used; the ratio of BHA and the milling ball was 1:20. The milling treatment was conducted for three, six, and nine hours in the milling vial.

2.3. Material Characterization

The compressive strength of the BHA-based and HA-based scaffolds was characterized by using a mini autograph (Autograph Microcomputer Control Universal Testing, LoadCell, YXC-1B (Original Equipment Manufacture, Surabaya, Indonesia), speed 5 mm/min).

The Ca/P ratio of materials was examined using SEM-EDX (EVO MA 10; Carl Zeiss, Oberkochen, Germany). The structural evaluation of particle size was examined using the same instrument and analyzed by measuring the mean particle size in at least two different axes using the ImageJ 1.52a software (National Institutes of Health, Bethesda, MD, USA).

The crystallinity of the materials was examined by using XRD (PANalytical X'Pert³ powder; PANalytical Corporation, Almelo, The Netherlands). The XRD pattern was corrected, and the XRD peaks were detected using Origin software (OriginLab Corporation, Northampton, MA, USA). The percent of crystallinity of each material was calculated based on area under peaks by using Origin software.

$$\text{Percent of crystallinity} : \frac{\text{Acrytalline}}{\text{Acrytalline} + \text{Aamorphous}} \times 100\% \quad (1)$$

The hydrodynamic particle size of materials was measured by using DLS (Delsa™ Nano C; Beckman Coulter, Indianapolis, IN, USA), while the functional chemical group of each material was examined with FTIR (Alpha II; Bruker, Leipzig, Germany).

3. Results

Prior to the fabrication and characterization of the material, a compressive strength test was conducted to compare the strength of BHA as natural form of HA with a synthetic HA (characteristics of HA are presented in Figure S1). Figure 1 shows that BHA had a higher compressive strength than the synthetic HA ($p = 0.0254$; unpaired t -test). This indicated that BHA is a compact material compared to HA.

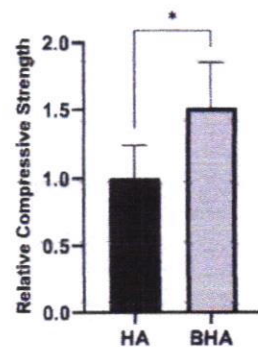


Figure 1. Relative compressive strength of BHA and HA. Each bar shows the mean \pm SD ratio. * $p < 0.05$ based on the unpaired t -test.

The strength of BHA indicated its brittleness, which may affect the submicron-BHA fabrication process. Thus, an appropriate method should be considered in the top-down fabrication process for BHA. In the current study, we chose the high-energy dry ball milling method to fabricate submicron BHA. Figure 2C shows that the particle size of unmilled BHA had a wide distribution range, from submicrons to $\sim 30 \mu\text{m}$, with a peak of ~ 5 to $\sim 10 \mu\text{m}$. Moreover, SEM images presented in Figure 2 also show that milling treatment reduced the particle size of BHA, both qualitatively and semiquantitatively. BHA samples milled for three, six, and nine hours were measured and found to have particle sizes of ~ 3 , $\sim 1 \mu\text{m}$, and in the submicron scale (Figure 2F,I,L). Moreover, all material was shaped hexagonally (Figure 2); this shape of BHA also differentiates BHA from synthetic HA (Figure S1A,B).

Milling treatment did not affect the characteristics of BHA based on its functional chemical groups. FTIR spectra showed that all materials had carbonate and phosphate groups present at a wavenumber of 1455 cm^{-1} and $1000\text{--}1100 \text{ cm}^{-1}$, respectively (Figure 3). Moreover, the carbonate group detected in all BHA samples was not present in HA (Figure S1C). The XRD pattern and peaks of unmilled and milled BHA are presented in Figure 4. BHA had 84.02% crystallinity, while BHA milled for 3, 6, and 9 h had 65.81%, 60.98%, and 60.70% crystallinity, respectively. In addition, the calcium-to-phosphorus (Ca/P) of unmilled and milled BHA ranged from 1.48 to 1.68 (Table 1). The Ca/P of all BHA samples (unmilled and milled) is higher than that found in synthetic HA (Figure S1E).

The current study also conducted a hydrodynamic particle measurement of the unmilled and milled BHA (Figure 5). This measurement was essential to predict the in vivo performance of BHA as submicron materials. In line with previous results by SEM (Figure 2), the milling treatment reduced the particle size of BHA over time. However, the hydrodynamic size of milled BHA was more extensive; the particle size was scaled in micron size with BHA milled for nine hours being the smallest.

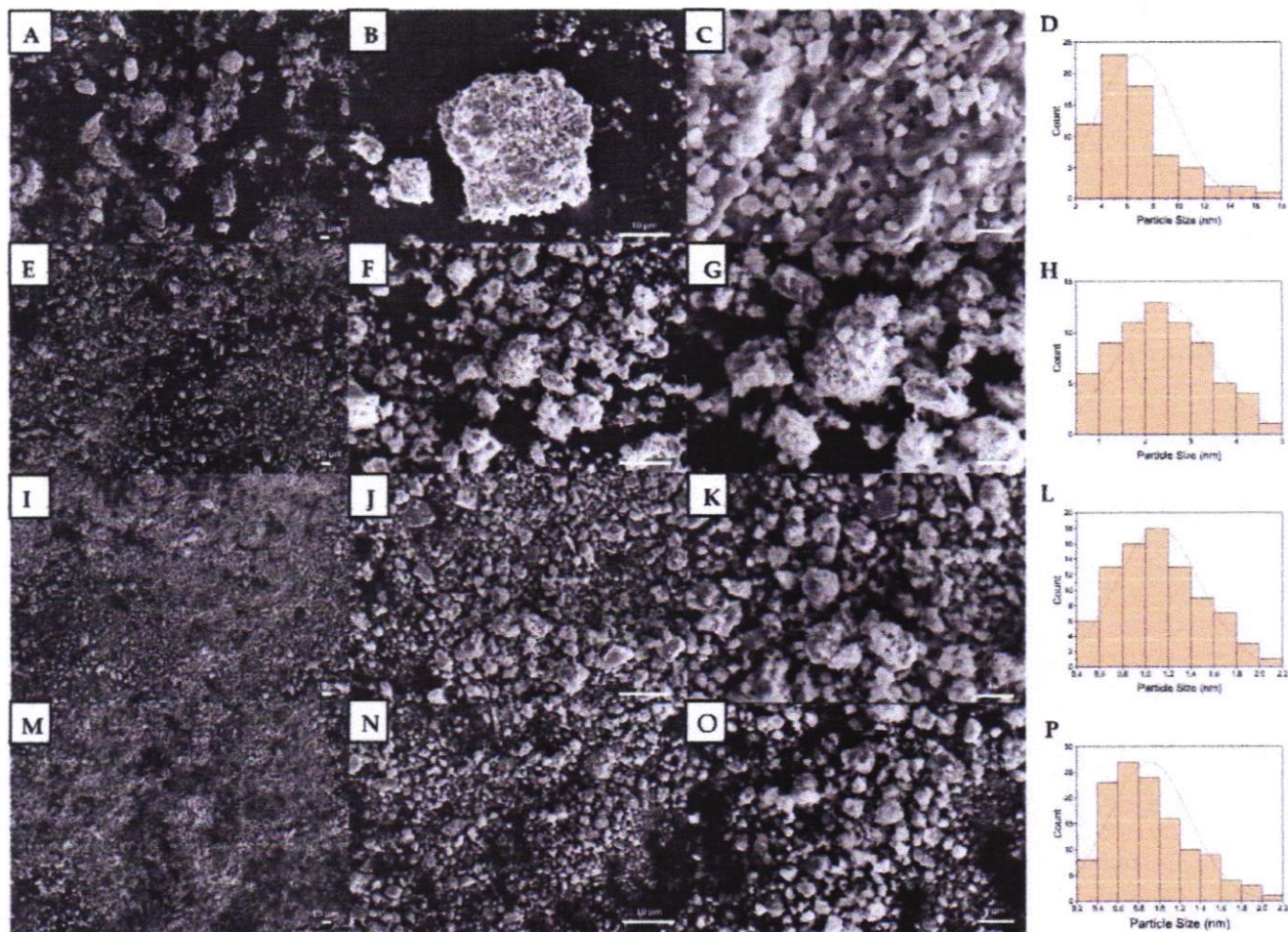


Figure 2. SEM images and particle size distribution of unground BHA (A–D), BHA milled for 3 h (E–H), BHA milled for 6 h (I–L), and BHA milled for 9 h (M–P). (A,E,I,M) Images show total magnification of 1000×. (B,F,J,N) Images show total magnification of 5000×. (C,G,K,O) Images show total magnification of 15,000×. (D,H,L,P) Graphs show the corresponding particle size distributions.

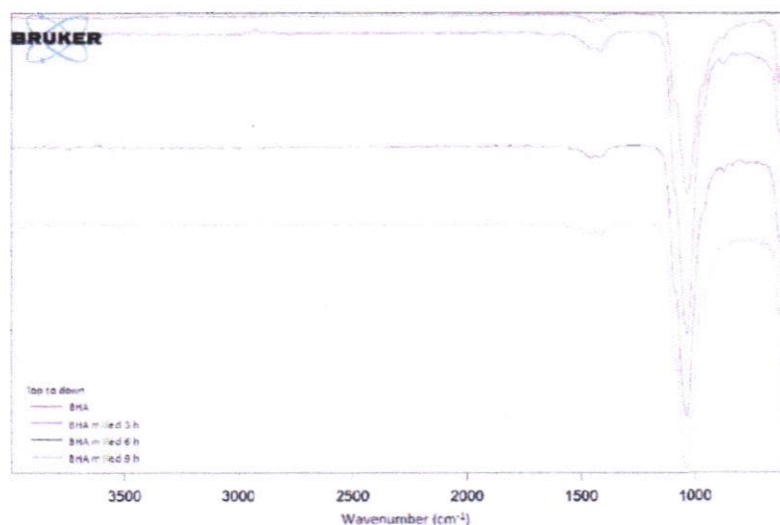


Figure 3. FTIR spectra of unground and milled BHA.

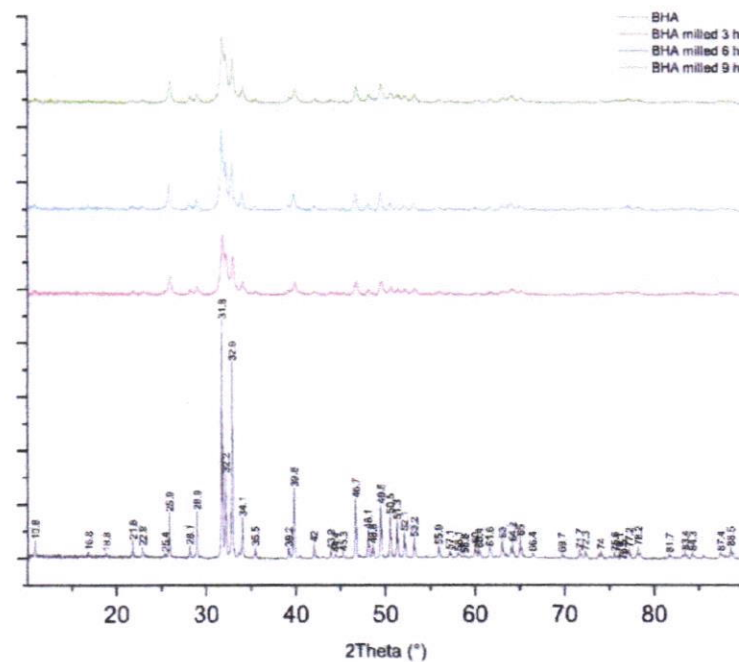


Figure 4. XRD spectra of unground and milled BHA.

Table 1. Ca/P ratio of unground and milled BHA.

Material	Calcium (Ca)		Phosphorus (P)		Ca/P Ratio
	Weight (%)	Atomic (%)	Weight (%)	Atomic (%)	
BHA	68.01	62.16	31.99	37.84	1.64
BHA milled 3 h	68.43	62.62	31.57	37.38	1.68
BHA milled 6 h	65.70	59.69	34.30	40.21	1.48
BHA milled 9 h	65.95	59.95	34.05	40.05	1.50

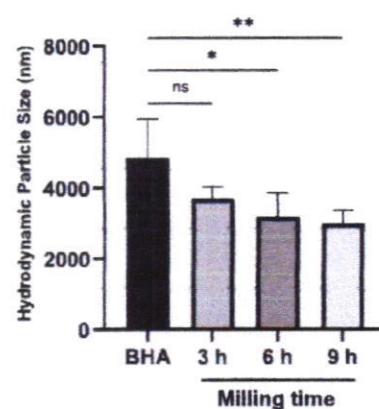


Figure 5. The hydrodynamic particle size of milled and unground BHA. Each bar shows the mean \pm SD value. * $p < 0.05$, ** $p < 0.01$ based on a one-way ANOVA test.

4. Discussion

The current study was conducted to fabricate submicron-scale BHA using the dry ball milling method with various milling times. This milling method uses no media in the milling treatment of materials. Milling media such as ethanol and other organic solvent are widely used as PCA in the milling method [28–30]. PCA functions to avoid cold welding and bonding between the powder particles. However, PCA is also known to change material characteristics [25]. In the case of the milling treatment of BHA, the use of PCA

may change its natural characteristics, which is not desirable. In the current study, we did not vary the milling speed because it was previously reported that milling speed did not influence the particle size of materials [31,32]. Although BHA is a material with high compressive strength, our study proved that a 9-h milling treatment successfully reduced the particle size of BHA to a submicron scale without changing the natural morphology of BHA. The hydrodynamic size of these materials was higher; however, the particle size of milled BHA was significantly smaller than unmilled BHA.

Our currently fabricated submicron BHA has been indicated to have a beneficial effect in bone tissue engineering. A previous study reported that submicron-scale materials (~500 nm) had a beneficial effect on osteoclast formation and function compared to nanomaterials [7]. This event is suggested to occur through the integrin–ligand protein interactions by protein adsorption [10]. In addition, submicron-sized ceramics (grain size: ~800 nm) have also been proven to enhance bone regeneration compared to microscale ceramics (grain size: ~2.5 μm) after 12 weeks of implantation in vivo [11].

Furthermore, our current study also proved that the milling treatment did not change the morphology of BHA. The morphology of these materials was similar to bovine-derived HA in our previous study [18] and the hydrogel composite HA in the study of Słota et al. [33]. This hexagonal-like morphology of biomaterials was reported to promote osteoblast adhesion after five hours of seeding [33]. This morphology is also present in the biomineralization of human bone mesenchymal stem cells [34], suggesting similar properties and better performance in vivo.

Moreover, our current study proved that the top-down treatment did not affect the characteristics of BHA based on its chemical functional groups. Both unmilled and milled BHA showed carbonate and phosphate chemical groups. This was similar to our previous study [18] and another study conducted by Michelot et al. [35]. The carbonate group in HA was reported to accelerate the differentiation and proliferation of osteoprogenitor cells to bone cells compared to uncarbonated HA [20]. Moreover, the carbonated HA was also reported to increase the gene expression of the collagen matrix [36]. In vivo studies also showed that carbonated HA, such as BHA, exhibited higher presentation of new bone formation and higher bone-to-material contact when compared to other types of HA [37,38].

Our current study also found that milling treatment reduced the crystallinity of BHA. Reductions in material crystallinity generally occurs because of milling treatment, such as reported by Ma et al. [39]. The study reported that a high-energy milling treatment reduced the crystallinity of MgCu. This incident is related to grain refinement and the impingement of milling balls with material, which decreased XRD peaks [39].

The Ca/P of human bone is generally considered to have a theoretical Ca/P ratio of 1.67 [40]. In the current study, we also examined the Ca/P of materials. This study showed that the Ca/P ratio of all materials was close to human HA [40]. Furthermore, the Ca/P ratio of 1.67 is also widely used as a reference value for bone grafts, rendering it suitable for orthopedic, dental, and maxillofacial implants [41,42]. Thus, the Ca/Pa value of fabricated submicron BHA supported the potential of this material to be used for bone implants. Moreover, calcium and phosphate play essential roles in bone tissue formation. Calcium ions stimulate the osteoblastic bone synthesis pathway, affects osteoblasts' life span, and regulate the formation and the resorptive functions of osteoclasts. On the other hand, phosphate regulates the differentiation and growth of osteoblastic lineage, increases the expression of bone morphogenetic proteins, and plays a role in the maturation of osteocytes [43,44].

To the best of our knowledge, our current study is the first study that considers the milling treatment of hard and dense natural HA without PCA. The non-hazardous method of milling treatment used in this study reduced the natural particle size of the material without affecting its characteristics. Considering the beneficial effects of submicron material and the characteristics of natural HA, submicron-sized natural HA may have beneficial effects in bone tissue engineering.

5. Conclusions

Submicron-scale natural HA fabrication was successfully conducted using a high-energy dry ball milling method. A milling time of 9 h decreased the particle size of BHA from micron to submicron scale. The milling treatment did not affect the natural characteristics of BHA marked by the morphology, chemical group substitution, crystallinity, and Ca/P ratio of the material. Thus, the submicron-scale BHA with innate characteristics of human bone may be potentially used as a biomaterial that could possibly have better in vitro and in vivo performance. However, further research regarding this should be proven in further studies.

Supplementary Materials: The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/ma15062324/s1>, Figure S1: Characteristics of synthetic HA.

Author Contributions: Conceptualization: M.A.G. and J.K.; methodology: A.S.B. and M.L.A.D.L.; software: M.A.G. and C.A.; validation: M.A.G. and J.K.; formal analysis: M.A.G.; investigation: M.A.G.; resources: A.S.B., M.L.A.D.L. and J.K.; data curation: M.A.G.; writing—original draft preparation: M.A.G.; writing—review and editing: M.A.G. and J.K.; visualization: M.A.G.; supervision: F.A.R., C.A. and J.K.; project administration: M.A.G. and A.S.B.; funding acquisition: J.K. All authors have read and agreed to the published version of the manuscript.

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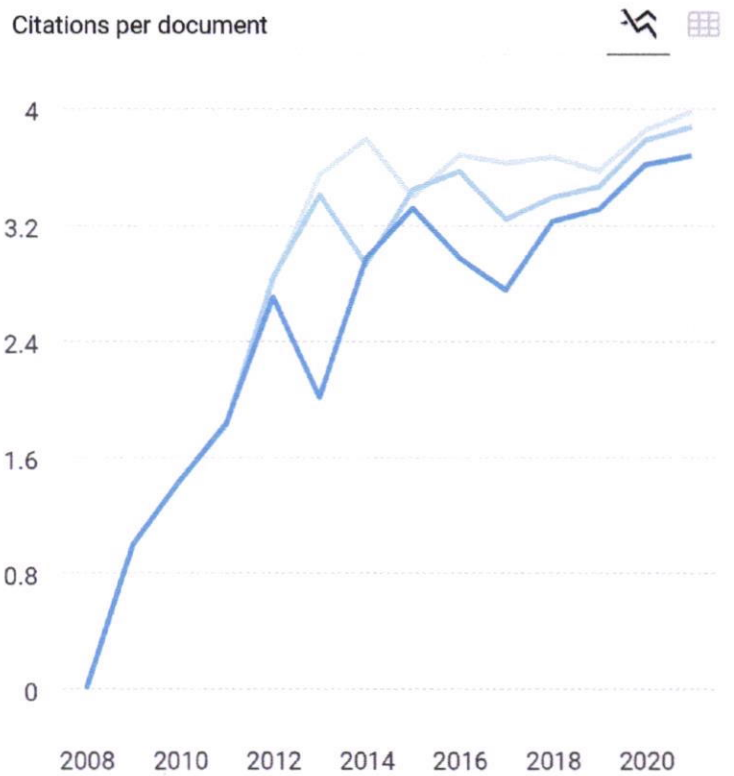
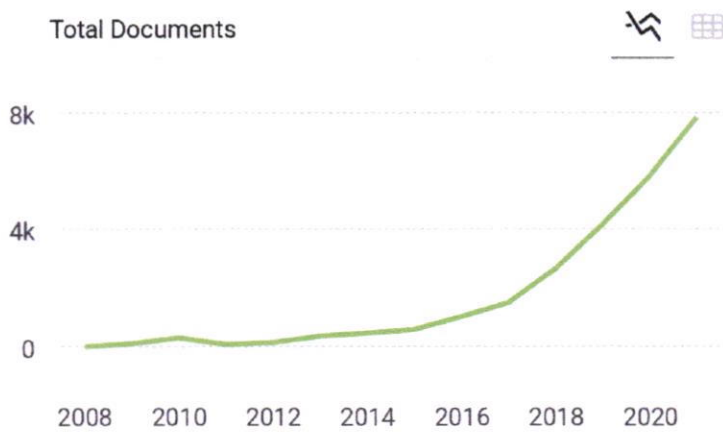
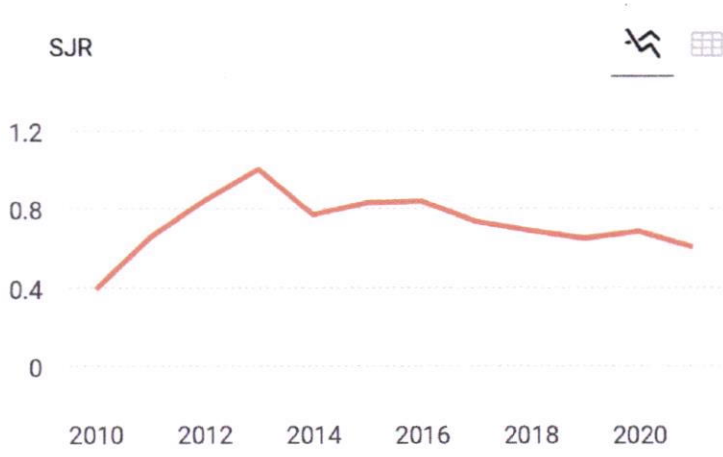
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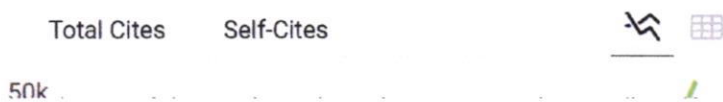
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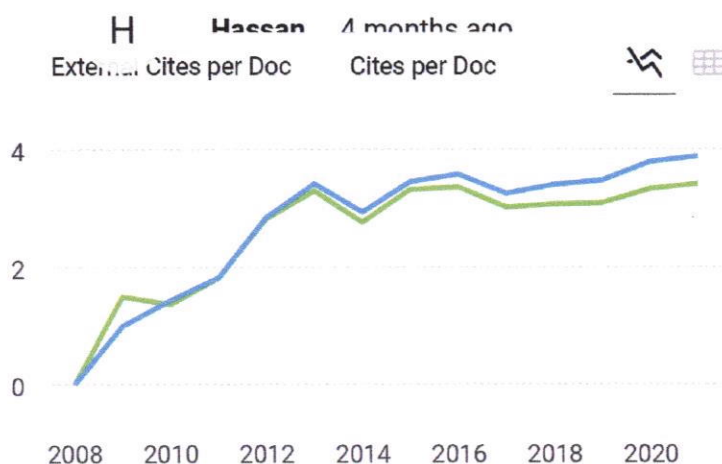
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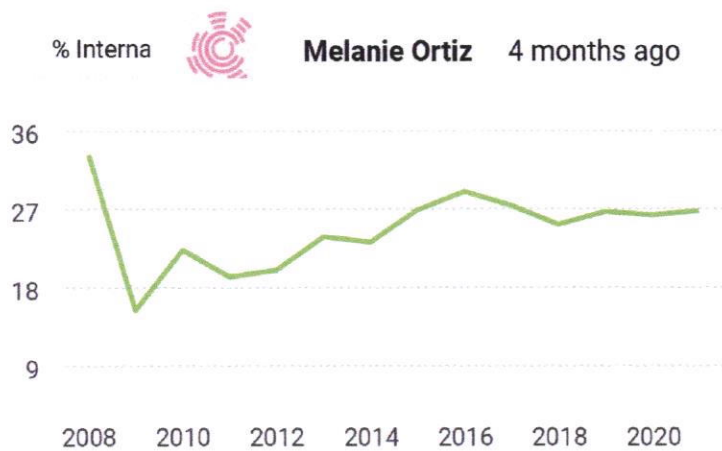


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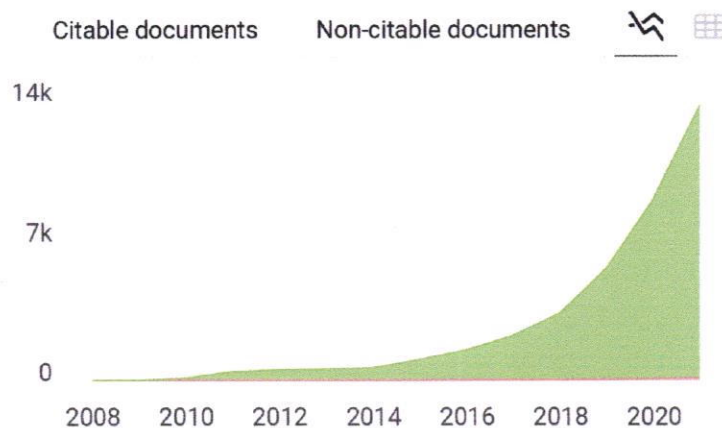
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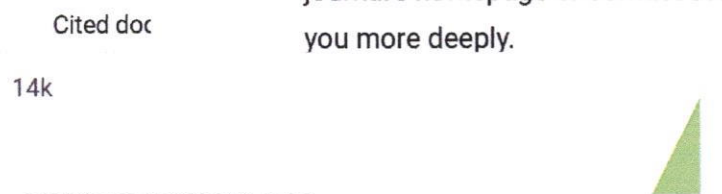
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K **kartika anoraga** 3 years ago

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R **Ricardo** 1 year ago

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