BMC Materials

EDITORIAL Open Access

The launch of *BMC Materials*

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Abstract

BMC Materials is a new, community-focussed venue for all publishable research across the broad discipline of materials science. It joins the mature and reputable BMC Series of journals, adhering to the same standards of publishing and the ethos of open research set by the Series. Together with its sister journals *BMC Chemical Engineering*, *BMC Biomedical Engineering*, *BMC Energy* and *BMC Chemistry*, *BMC Materials* furthers the BMC Series' expansion into the physical sciences and engineering.

Introduction

The importance of materials research

Materials science is a truly multidisciplinary field where advancements made in new materials development, the discovery and improvement of materials properties and their processing and application underpin research discovery across science and technology. Further strengthening the relevance of materials research to so many disciplines is its reach from the atomic to macro scale.

Materials able to perform different and multiple functions will become increasingly important, and they will be designed specifically to do so. For instance, materials able to be lighter than, yet as resistant as, steel are desired for a broad range of applications, such as in aerospace engineering. The same is true of materials able to perform as sensors and actuators accordingly in response to external environmental conditions, but the design of such materials is still challenging. Another area in need of further research development is in processing devices that exhibit ultra-low power consumption, are reliable and demonstrate outstanding electronic performance. They must be fabricated using the smallest possible number and amount of recyclable materials, thereby contributing towards a sustainable industry and striving for a zero-waste society. Sustainability is an important driver for materials research, where there is a need to develop new materials that allow us to continue our technological progress without relying on rare and unsustainable materials or irreversibly depleting essential resources.

Another critical issue that deserves our attention in the near future concerns the development of materials for energy applications, targeting innovation in the field of piezo and thermo-electricity, nano-generators, solar cells, supercapacitors, and batteries for micro-power generation. The proper selection of materials and the way in which they are integrated into products is a key issue that defines our present state-of-the-art, and will determine our future exploitation of materials as an activator and a tool for progress in science and technology. From employing tailored biomaterials for the improvement of cell transplantation and to help tissue regeneration [1], to the development of stimuli responsive materials allowing active control of construction materials [2], materials science research is paramount to progress across all science, technology, engineering and mathematics (STEM) disciplines.

The use of techniques from emerging fields such as machine learning, data science and advanced manufacturing in materials development is ensuring that materials science remains relevant and integral to all new technologies. Modelling and simulation advances mean that the properties of new materials can be predicted and tuned without the need for large numbers of empirical tests, allowing the field to move faster than ever. This is seen in the successful Materials Genome Initiative, which combines experiment, theory and computation to design and to realise new materials for application in medicine, energy, catalysis, transportation and computing. With

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further investment in this and other projects materials can, and will, provide the solutions to our global sustainability challenges [3].

A new open access publishing venue

The speed at which the materials science field moves, and the potential that it has for meeting the UN Sustainable Development Goals (SDGs) [4], mean that there is a growing volume of research that needs to be shared. *BMC Materials* aims to ensure that this research is accessible to all to read and build upon to ensure that the dissemination of quality research does not create barriers to discovery.

The BMC Series has always been a champion of open research, and we have recently partnered with Research Square to make the editorial process more transparent. Through our optional service *In Review*, authors can make their pre-publication manuscripts visible to others to read and comment on, as well as follow in detail the progress of their manuscript through peer review. More details about this pioneering new service are available on our website [5].

In line with the other BMC Series journals, *BMC Materials* is divided into six sections as follows [6], designed to span the breadth of the materials science field and ensuring that all fundamental and applied materials research can find a suitable home in this journal.

- Structural materials
- Functional materials
- Energy materials
- Biological and biomedical materials
- Polymeric materials
- Materials for interfaces and films.

Our sections are led by top academics in these fields and are supported by a renowned, international editorial board [7]. Our Section Editors Dr Pedro Barquinha, Dr Wenguo Cui, Dr Drew Evans, Professor Emmanuel Kymakis, Professor Haiyan Wang and Professor Ehrenfried Zschech [8] describe the aims and scope of the different journal sections in detail here.

Editorial sections

Structural materials

Structural materials are materials used or studied primarily for their mechanical properties. This can include a materials response to an applied force, whether this response is elastic or plastic, its hardness, and its strength. One example of leading-edge research in the field of structural materials are "Adaptive Structural Materials", i.e. next-generation metallic materials with high-strength and high-ductility. Structural materials could also be designed to have integrated electrical, magnetic, optical, actuation, power generative, and possibly other functionalities that work in synergy to provide advantages that reach beyond those of the sum of the individual capabilities.

Modern intelligent lightweight engineering, more than ever before, requires materials-driven product innovations in industry and shorter times-to-market for new products. This requires high innovation rates and sustained developments in materials science and engineering. Mechanical testing and analytical techniques and respective tools to characterize structural materials as well as modelling and simulation are considered to be fundamental drivers for innovation in industry.

This section covers all aspects of design, processing, development and application of structural materials, considering all classes of materials including metals and alloys, ceramics and glasses, polymers and composites. The scope includes fundamental and applied papers on innovative manufacturing processes, as well as on materials' microstructure and materials' mechanical properties.

The section particularly welcomes original papers from the following topic areas:

- Materials for lightweight engineering, including composites and skeleton materials
- Materials synthesized with additive manufacturing processes
- Hierarchically structured materials, learning from nature (biomimetics)
- Self-healing structural materials
- The effect of environmental conditions and use profiles on the mechanical properties of materials
- Multi-scale modelling and simulation and multi-scale materials characterization
- Non-destructive testing of materials.

There is a main emphasis on mechanical properties of materials, with a particular focus on kinetic processes of materials ageing and degradation on the micro- and nano-scale.

Functional materials

The discovery and development of functional materials has driven recent advances in the design of new devices and structures for various technically important areas. With the recent progress in nanomaterials, exploring novel functionalities enabled by nanoscale designs has become one of the major research topics in the field of materials research. This section welcomes materials research with a focus on functional materials. This includes fundamental and applied material research for a broad range of materials functionalities including

electrical, magnetic, optical, thermal, electrochemical properties, as well as multi-functionalities combining more than two functionalities. Materials systems include but are not limited to ceramics, metals, polymers and organic molecules in the forms of bulk, thin films, powders, nanocomposites and nanostructures. The section also considers fundamental and enabling materials research in design, processing and characterization and new approaches to expedite such feedback loops. Materials applications cover microelectronics, optoelectronics, optical devices, sensors, attenuators, and beyond.

Energy materials

This section considers all materials' science and engineering research related to energy generation, conversion, saving and storage. This includes, but is not limited to, work on organic, inorganic, perovskite and hybrid photovoltaics (PVs) and related (nano-) materials; thermoelectric materials and thermoelectric generators (TEGs); materials for batteries, supercapacitors and fuel cells as well as high efficient energy storage devices; electrochromic and thermochromic materials and devices; energy harvesting (nano-) materials i.e. triboelectric, piezoelectric, etc.; solar fuels for hydrogen generation; water splitting, photocatalysis and electrocatalysis.

The section welcomes contributions ranging from fundamental and theoretical work, materials development, materials characterization, device fabrication and scalable high-throughput processes i.e. roll-to-roll printing and/or vacuum deposition technologies for large-scale production of devices; modelling and integration of devices at system level. An important and highly respected aspect for this section will be also the research focus on hierarchical multi-scale materials that can result into multi-functional nanotechnology-driven bulk objects/structures (e.g. self-powered sensors, hybrid devices, etc.). Moreover, application of nanomaterials in 2D and 3D additive manufacturing (AM) is covered within the scope of this section.

Finally, the application of nanotechnology and nanomaterials in Buildings and Construction for i.e. electrically conductive cement nanocomposites, piezoresistive cements with strain sensitive behavior, thermoelectric cements, etc. is highly recommended within the scope and research to be published by this section.

Biological and biomedical materials

Biological and biomedical materials play essential roles in studying the artificial organs and medical devices, which is of necessity to keep human healthy. In particular, the development of appropriate materials is of critical importance to bridge the gap between fundamental laboratory research and clinical practice, and thus launch products for biological and biomedical applications. The anticipated products usually involve a broad range of species, such as scaffolds used for tissue repair, membranes related to blood purification and separation, tissue adhesives, sutures, carriers for drug delivery, anticancer complexes, contrast agents, biosensors, etc. As such, the study and exploitation of biological and biomedical materials is the most essential part of the work aimed at solving health challenges in the field of biomedicine.

The Section "Biological and biomedical materials" of BMC Materials aims to publish original research and review articles covering all aspects of material science in medicine and biotechnology. More specifically, papers reporting the synthesis of innovative biomaterials, interactions of nanomaterials with cells, tissues, and living organisms for regenerative medicine, controlled drug release/delivery, toxicology, diagnostics, and improved therapeutics are of particular interest. Broadly the section also seeks papers encompassing:

- synthesis, bioavailability, and biodistribution of nanomedicines
- pharmacodynamics and pharmacokinetics of nanomedicines
- imaging
- public health, point of care monitoring, and nutrition
- nanomedical devices and prosthesis
- biomimetics and bioinformatics.

Both fundamental research and applied papers are welcome in view of the comprehensive aim of *BMC Materials*.

Polymeric materials

Polymers have become ubiquitous in our daily lives—beyond readily processable plastics to highly engineered polymers found in everything from our food to aerospace to consumer electronics. The future of these polymeric materials appears exciting, although mixed with challenges around their use, their recycling and their end of life degradation. To reflect the need for new understanding and application, *BMC Materials* welcomes papers in the general area of *Polymeric Materials*. The aim of this section is to showcase the ways in which polymers contribute to many different aspects of daily life. Herein papers spanning the breadth of research from fundamental understanding to new or improved synthesis to applications thereof will be sought. This reflects that polymer research has matured as a research field to encompass quite a diversity of different activity and focus. Without being restrictive, *BMC Materials—Polymeric Materials* seeks to publish papers across these broad areas:

- Experimental, theoretical and/or computational
- Properties from electrical to optical to mechanical to thermal and beyond
- Interaction of polymers with their surrounding environment
- Applications in chemical, agricultural, food, pharmaceutical, biomedical, engineering and energy.

Materials for interfaces and films

The use of materials in the form of films is a crucial area in materials science, with immediate application to a variety of scenarios. Whether in the form of nitride-based hard coatings for improving wear, oxidation, and corrosion resistance of cutting tools and machine parts; as complex film coating formulations in drug delivery systems, where opacifying agents as TiO_2 can be added to stabilize light-sensitive drugs or iron oxide pigments can provide elegant dosage forms and facilitate product identification; or even as oxide semiconductors with embedded metallic nanostructures to enable ultra-fast electronic performance in flexible and transparent thin-film transistors (TFTs), just to name a few. While achieving the desired performance for a given application is certainly a key aspect for the selection of film materials and deposition processes, sustainability has been gaining increased relevance. Good examples are biopolymers, which nowadays can be prepared as edible films for food applications, or indium-free oxide semiconductors such as zinc-tin oxide (ZTO) prepared by spin or spray-coating replacing mainstream sputtered indium–gallium–zinc oxide (IGZO).

Films necessarily bring interfaces into play. In the well-known words of the physicist Wolfgang Pauli, "God made the bulk, the surface was invented by the devil". In fact, internal interfaces in complex compositionally-graded nanoscale multilayers, or between semiconductor and insulating materials in electronic devices or simply the air-film interfaces in all sorts of systems can have a negative impact on the final properties of a given material or device. On the other hand, understanding how these interfaces work, how the physical and chemical interactions occur on them, can not only solve fundamental problems on those materials and devices but also give rise to amazing sensing applications. As such, interface study and control is a crucial aspect of film research.

With this background in mind, the section "materials for interfaces and films" was conceived to publish contributions enabling significant advances on the properties of organic and inorganic coatings, thin films and interfaces, as well as on understanding their physical, electrical, chemical, electrochemical and photochemical performance. This includes papers dealing with film growth, post-growth processes, film and/or interface characterization, material design, modelling and device integration.

Conclusion

BMC Materials joins the successful BMC Series to provide an inclusive, community-focussed venue for research across the full breadth of materials science. By adhering to the open research values of BMC, it aims to facilitate the rapid and unrestricted dissemination of quality research to ultimately aid the development of materials.

We hope that the first *BMC Materials* articles are valuable to the community and we look forward to working closely with our authors, reviewers, readers and editors in the coming months and years as this journal evolves.

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