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"Frontiers in ceramics" grand challenges

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Ceramics are classified as inorganic and non-metallic materials that are essential to our daily lifestyle and have a long history of development. Archeologists have uncovered human-made ceramics that date back to at least 24,000 BC[1]. Clay minerals of alumina-silicates remain the most widely used raw materials for producing traditional ceramic products (Carter, 2013). The ceramic products from clay includes earthenware, porcelain and bricks which have also been in use in our daily life for a long time.

Development of advanced ceramics has led to production of ceramic matrix composites, ceramic coatings, electro-ceramics, bioceramics and optical glass fibres, etc. Nowadays ceramics are found in products like watches, snow skies, automobiles and phone lines[2]. Depending on their method of formation, ceramics can be dense or/and lightweight. Typically, ceramics demonstrate excellent strength and hardness properties, being stable and chemically inert in corrosive environments (Carter, 2013). Various mechanical, chemical, electrical, magnetic, optical and thermal properties can be obtained using various ceramics, which would be difficult with other materials. However, ceramics are often brittle in nature. It is more difficult to manufacture ceramic components than is the case with metals and polymers. In addition, a wide range of ceramics have been investigated for industrial applications, and different processing techniques have developed to manufacture ceramics (Carter, 2013). Therefore, multi-disciplinary investigation is required for study of ceramic materials and it is difficult for a single scientific journal to cover all ceramic research topics. Thus, a new journal "Frontiers in Ceramics" has been launched with intent to cover four sections initially: *Ceramic Processing*, *Ceramic Structure-property Relationship*, *Ceramic Applications* with focus on functional ceramics, and *Ceramic Technology* to cover coating technology, nanotechnology, and traditional ceramics in additional to advanced ceramics[3].

Both chemical and physical methods have been used to produce ceramic powders. Ceramic powders can be transformed into green ceramics of different shapes *via* ceramic forming techniques, followed by sintering of green ceramics into consolidated ceramics (Reed, 1995). On the other hand, different ceramic processing techniques have been and are being developed to produce ceramics which are difficult or expensive to produce *via* the powder forming and sintering route. Ceramic processing routes are much wider than those used to manufacture metallic and polymer products, although some ceramic forming techniques are similar to those employed for manufacture of metal and polymer components, e.g., casting and extrusion. Overall, it is difficult to summarise all ceramic processing techniques, as they are wide range, evolving and progressing continuously.

Ceramic structure controls properties including mechanical, electrical, thermal and optical properties (Lee and Rainforth, 1994). Progress in ceramic processing, coupled with advances in ceramic characterisation techniques, has promoted fundamental understanding of ceramic microstructure-property relationships and led to invention of many new ceramic products with

1 http://ceramic-art.uk/history-of-ceramic-art/.

2 https://depts.washington.edu/matseed/mse_resources/Webpage/Ceramics/ceramics.htm.

3 https://www.brick.org.uk/admin/resources/g-the-uk-clay-brickmaking-process.pdf.

enhanced functional and mechanical properties. Modern electron microscopy allows scientists and engineers to examine fine structured ceramics while improvements in electrical, thermal and optical measurements have enabled advances in application of ceramic products. Mechanical testing of ceramics at the micro- and nano-scale enhances development of structural ceramics significantly. Nevertheless, it is a challenge to establish an accurate relationship between microstructure and any relevant functional (electrical, mechanical, thermal, optical) property, as these properties can vary significantly with change in microstructure of ceramics.

The wide range of properties exhibited by different ceramics has led to many applications of ceramics. Functional ceramics are designed for special applications requiring additional properties such as electric, magnetic or optical. For electrical applications, electro-ceramics like ferroelectric, multi-ferroic and piezoelectric materials have been widely used for various devices. Ceramics have been used in production of sensor and active devices. Battery devices and solid oxide fuel cells contains ceramic components. In addition, bio-ceramics are used for dental applications and bone replacements. The list of ceramic components and devices is extensive; therefore, it is difficult to cover all of applications of ceramics in any single journal not specifically focused on ceramics.

Ceramics technology aims to realise ceramic components, with properties which cannot be achieved with use of other materials like metals or polymers. Ceramic thin film and coating technologies have been developed to enhance resistance to corrosion, erosion and wear. Nanotechnology enables ceramics to achieve enhanced mechanical, electrical and optical properties. Traditional ceramics still occupy a large share of the ceramics market but face challenges in reducing cost of manufacture and minimisation of energy usage and environmental pollution during manufacture of ceramic components[3]. Overall, ceramic technology should address challenges to achieve the net-zero target, particularly as ceramics' manufacture in general tends to consume significant energy during the manufacturing process.

Frontiers in Ceramics aims to publish original and high-quality research contributions related to ceramic processing, ceramics structure and properties, ceramics technology and applications. The topics range from ceramic powders' synthesis to devices where ceramics are used as components. The journal intends to cover a wide range of topics related to fundamental and applied research on ceramic materials, covering both advanced ceramics and traditional ceramics. As a new Field Chief Editor, I am supported by four outstanding Speciality Chief Editors who will be responsible for topics of Ceramic Processing, Ceramic Structure-property Relationship, Ceramic Technology and Ceramic Applications and an excellent Editorial Office to support us as editors.

We aim to launch the journal Frontiers in Ceramics in early 2023, and encourage colleagues working in the field of ceramics to engage with us to improve the journal for the international scientific community.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

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