Editorial for advanced structural ceramics technology and characteristics

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It is our great pleasure as Guest Editors of the journal “Rare Metals” to present the special issue on “Advanced Structural Ceramics Technology & Characteristics.” It provides the most recent research developments in advanced structural ceramics technology and characteristics and their applications in the potential industrial application. During the twenty-first century and the following decade, industrial ceramics have made significant contributions to various fields, including electronics, communications, transports, aeronautics, astronautics, environment, and energy. Many of these new ceramics products have made tremendous contributions to our society. It may not be an exaggeration to say that ceramic products in fact enhance the quality of our daily lives. Over the years, China has spawned many world-class-level ceramics manufactures that have provided many highly functional, high-quality ceramic products and exported them worldwide. This would not have been possible without the fundamental and important research contributions from universities as well as by industries utilizing continuous product improvements resulting from advanced structural ceramics technology and characteristics.

This special issue is a collection of advanced structural ceramics technology and characteristics that have played active roles in various fields of industry used in the current society. In addition, we have included different original researches or important reviews in the issue. There is

probably not a single issue that has categorized ceramics to play in each field and realizes how ceramics continue to play important roles in improving the quality of our lives. Even at this very moment, many scientists in universities or engineers in industry are working hard to develop new and innovative products. In this special issue, we invite world-renowned experts in advanced structural ceramics technology and characteristics fields focusing on different specific aspects to report their interpretations on past progress and perspectives on future development.

The main contents in this issue are as follows:

High thermal conductivity silicon nitride ceramic substrates are indispensable components for next-generation high-powder electronic device, which possess excellent mechanical properties while maintaining high thermal conductivity, compared with other substrate materials. A review by Xie et al. [1] gives an overview on recent developments in preparing high thermal conductivity silicon nitride ceramics.

Thermal/environmental barrier coatings (T/EBCs) play important roles in jet and/or gas turbine engines to protect the Ni-based superalloys and/or ceramic matrix composite substrates from the high-temperature airflow damage. Plasma spray–physical vapor deposition (PS–PVD) is a unique processing technology and enables highly tailorable functional film and coating with various rare metal elements. PS–PVD technology, which has broad application prospects in the fields of thermal barrier coatings, environmental barrier coatings, oxygen permeable films, electrode film, etc., was summarized by Yang et al. [2]. And the progress on the fabrication techniques and mechanical/thermal properties of thermal/environmental barrier coatings, together with the anti-corrosion performance of these rare earth-based T/EBCs under a condition of molten salts or CMAS, are summarized by Yang et al. [3].

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Graphene nanoplatelets (GNPs) are considered to be one of the most promising new reinforcements due to their unique two-dimensional structure and remarkable mechanical properties. In this issue, a variety of methods employed for incorporating GNPs into ceramic matrices and consolidation techniques for fabricating bulk ceramic matrix composites are discussed by Wang et al. [4].

B₄C matrix composite intended for armor applications still presents restrictions such as low sintering density, production of large parts, and inherited brittleness. In this review, the material outlook for armor applications is organized by Wu et al. [5] from the developments of composite armor and ceramic materials for armor to B₄C matrix composite and reactive sintering method, including the mechanism, evaluation method, and influencing factors of anti-penetration for ceramic armor and B₄C matrix composite.

The thermal barrier coatings (TBCs) are one of particular interests regarding their potential usage as gas turbine, aerospace, power generation industries, and other fields. YTaO₄ ceramics have been considered as the promising candidates for the next-generation TBCs due to their high melting point, low thermal conductivity, high thermal expansion coefficients, good high-temperature phase stability, ferroelasticity, etc. Feng et al. [6] have selected MgO as the doping materials in order to optimize the thermal properties of YTaO₄ ceramics, including heat capacity, thermal diffusivity, thermal conductivity, and thermal expansion coefficients.

Hexagonal boron nitride (h-BN) has a crystal structure similar to graphite. The special crystal structure brings h-BN a sequence of unique properties, for instance, extremely high sublimation temperature, excellent thermal shock resistance, good machinability, chemical inertness, good thermal conduction, low dielectric constants and loss tangent, and good lubrication property. Therefore, h-BN ceramic matrix composites are widely used in aerospace, metallurgical, and chemical engineering fields. The present work from Duan et al. [7] was devoted to preparing h-BN ceramic matrix composites by taking Y₂O₃ and AlN as liquid-phase sintering additives in the original research.

Geopolymer has been considered as an appealing candidate for refractory, precursor for high-temperature ceramic products, encapsulation materials for hazardous waste, and wave-absorbing materials due to its ideal thermal stability, chemical stability, and dielectric properties. In this issue, SiO₂/phosphate geopolymer composites with different fiber contents were prepared and in situ crack growth, crack propagation, and fracture behaviors were reported by employing an environmental scanning electron microscope from He et al. [8].

The PcBN composites become an excellent cutting tool material with great potential and rapid development. In this

issue, dense PcBN composites were fabricated by HPHT using polysilazane (PSN) and Al as a sintering additive. It is the first time that PSN was used for the preparation of PcBN composites by Wang et al. [9]. The sintered PcBN composites exhibit high hardness and high flexural strength.

In recent years, due to its short preparation cycle, low cost, high accuracy, and other outstanding advantages, stereolithography-based 3D printing has seen wider use in industrial applications. Alumina ceramic cores produced with stereolithography have been used to manufacture hollow turbine blades in aircraft engines. In this issue, the effects of heating rate during vacuum debinding on open porosity, mechanical properties, and physical properties of an alumina ceramic were investigated by Liu et al. [10].

Sialon, a high-end structural ceramic, is widely used in many fields since it possesses a series of excellent properties. The conventional industrial method for the production of sialon is direct nitridation of Si, Al, and Al₂O₃ powders. In this issue, sialon ceramics were prepared with transition metals (Fe, Co, and Ni) at 1400 °C to enhance the degree of nitridation reaction by Huang et al. [11].

The cutting technology has been developed from the traditional mechanical-based cutting technology to the special cutting methods with additional energy, such as conductive cutting, vibration cutting, ultra-high-speed cutting, low-temperature cutting, heating cutting, and other special cutting technologies. In this issue, by Yang et al. [12], YG8-cemented carbide tool material is taken as the research object and cutting performance of cemented carbide tool is discussed, providing theoretical guidance for the better use of pulse current treatment technology in practical production.

We would like to sincerely thank all the reviewers for their valuable contribution that ensured the original research or the high-quality reviews to be published in this special issue. We are looking forward this issue to help readers more knowledge of this field.

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