ACHIEVING SUPERIOR CERAMICS AND COATING PROPERTIES THROUGH INNOVATIVE PROCESSING

This special issue of the Journal of Materials Research contains articles that were accepted in response to an invitation for manuscripts.

Introduction

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The development and implementation of new materials and innovative processing methods propel next-generation technologies and devices, improve their quality and reliability, and increase manufacturing productivity. Advanced ceramics are considered one of the most promising areas in the creation of new technologies. As is well known, the properties and performance of ceramics, composites and coatings strongly depend on processing routes and their features. At the same time, innovative or improved technologies may allow for the production of materials and components with unique properties, which could not be obtained using "customary" processing methods.

There are particular demands for advanced ceramics and composites with high reliability and specialized or complex shapes for a multiplicity of applications. Therefore, novel or optimized processing is a necessary part their development. Engineering components may have a variety of textures and structures, from fully dense to highly porous, with a uniform or heterogeneous microstructure when one or a few phases are bonded by similar or dissimilar materials or reinforced by fibers, whiskers or particulates. These criteria direct the selection and preparation of starting materials with controllable properties. Starting materials define, to a great extent, not only the final materials properties, but the technology and processing route. The colloidal processing should be emphasized in the manufacturing of components with high reliability, regardless of the forming method. As another key point of the advanced materials technology, the materials consolidation and structure formation should be outlined. Only the combination of the optimized colloidal processing, forming method and firing or consolidation provides the desirable ceramic microstructures and reduced level of flaws, internal micro-stresses and irregularities, which adversely affect the reliability and reproducibility of ceramic components and composites. This point is particularly important in large-volume industrial manufacturing. The appropriate control and management of the ceramic and composite microstructures with minimal stress to grain boundary conditions or the coating structure and the coating-substrate interface can provide reliability of the components.

Hence, any future progress in the field of innovative processing should be based on improvement of existing technologies or, alternatively, on the development of new approaches with an emphasis on routes allowing the near-net formation of ceramic structures, while optimizing the design of new materials and of the part architecture.

This Focus Issue is devoted to recent advances in ceramic and coating properties and performance as achieved through innovation in processing of advanced ceramics, composites and coatings. Some papers demonstrate the connection of processing features with application properties and performance of advanced ceramics and coatings. The aspects of processing considered include:

- novel technology of starting materials preparation;
- ceramic colloidal processing;
- novel forming technology of ceramics and composites, including for complex-shape products;
- advanced methods of ceramic and composite coating formation;
- novel consolidation technology and sintering features;
- design-oriented technology.

The majority of these 24 papers were prepared at the personal invitation of the editors, recognized ceramic specialists from academia and industry research centers. The authors come from different countries in North and South America, Europe, Asia and Australia, and some of them demonstrate a successful collaboration between the organizations from across the world.

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As guest editors, we are grateful to all the authors who contributed their manuscripts to this *Journal of Materials Research* Focus Issue, as well as to all reviewers for their work and advice. We hope that this Focus Issue will be interesting and useful for many ceramic and advanced materials specialists from academia and industry who work with the development and manufacturing of ceramics, composites and coatings, as well as the specialists working with advanced materials in modern devices and technologies.

ON THE COVER:

Ti_3SiC_2 is a material of extensive interest due to its unique combination of both ceramic and metallic properties. It has often been considered as a promising material for high-temperature applications. Synthesis of Ti_3SiC_2 materials often leads to dense samples due to the use of fabrication processes such as hot isostatic pressing. Paper-derived Ti_3SiC_2 has a high porosity because of the preceramic paper processing used in its fabrication. This technique allows for the manufacture of ceramics with complex geometric shapes for a broad field of applications. Paper-derived Ti_3SiC_2 combines the advantageous properties of the fabrication process and Ti_3SiC_2 respectively and is, therefore, representative of a superior ceramic material.

The kink band formation results from the plastic anisotropy. The typical laminated nature of MAX phases can be seen on the fracture surface of paper-derived Ti_3SiC_2.

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