frontiers | Frontiers in Materials

TYPE Editorial
PUBLISHED 21 December 2023
DOI 10.3389/fmats.2023.1346272

OPEN ACCESS

EDITED AND REVIEWED BY
Valeria Cannillo,
University of Modena and Reggio Emilia, Italy

*CORRESPONDENCE
Jiang Guo,
guojiang@dlut.edu.cn

RECEIVED 29 November 2023
ACCEPTED 05 December 2023
PUBLISHED 21 December 2023

CITATION
Guo J, Tong Z, Wang C, Bai Q and Zu Y (2023), Editorial: Preparation and post-processing technology for high-performance ceramics and optical materials.
Front. Mater. 10:1346272.
doi: 10.3389/fmats.2023.1346272

Editorial: Preparation and post-processing technology for high-performance ceramics and optical materials

Jiang Guo[1]*, Zhen Tong[2], Chunjin Wang[3], Qian Bai[1] and Yufei Zu[1]

[1]State Key Laboratory of High-performance Precision Manufacturing, Dalian University of Technology, Dalian, China, [2]School of Mechanical and Engineering, Shanghai Jiao Tong University, Shanghai, China, [3]State Key Laboratory of Ultra-precision Machining Technology, Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong SAR, China

KEYWORDS

post-processing, high-performance, ceramics and optical materials, manufacturing, testing

Editorial on the Research Topic
Preparation and Post-Processing Technology for High-Performance Ceramics and Optical Materials

New developments in science and technology are increasing the demand for novel materials. Ceramics and optical materials have attracted considerable attention in recent years due to their processing and performance characteristics. These are a special class of materials with a wide range of potential applications.

Ceramics and optical materials are amorphous or microcrystalline materials with excellent optical and mechanical properties, extensively to be used in micro-space optical devices, laser systems, optoelectronic devices, and other fields. When compared with conventional single-crystal materials, ceramic and optical materials are more cost-effective with a better manufacturing process. There is growing interest in this material due to its affordability, ease of manufacture, and ability to be processed into large blocks. It also has low production costs and desirable qualities.

Over the years, many innovators in the field of high-performance ceramics and optical material preparation and post-processing techniques have emerged. Some of them are discussed below (note: the list can be long).

— Masahiko Yoshino, a scientist from Tokyo, discovered that when GaSb crystals are nano-scratched under linear loading conditions, several factors cause plastic deformation of the material. (Yoshino, 2016)
— Lars Kahlman, an application specialist at SKF with extensive knowledge in mechanics of materials. (Axen, 1997)
— Lamy Bernard, based in Centrale Nantes, Nantes, France, focuses on the stiffness properties of composite materials. (Lamy, 1984)
— Berlie J, from Institut CERAC S.A., Ecublens, Switzerland, specializes in bearing material properties. (Lamy, 1984)

Driven by rising demand, optical ceramic materials are poised for a wide range of applications. These materials can be employed in the fabrication of precision optical devices such as optical lenses, floor mirrors, filters, and wave plates. They also hold promise in the manufacturing of large optical components for solar cell components, navigation systems, and environmental monitoring systems. In addition, optical ceramic materials find applications in laser systems, optoelectronic devices, and other disciplines, highlighting their diverse application potential and substantial commercial value.

The deformation characteristics of GaSb are investigated by employing nano-scratch tests to understand the material removal mechanism during ultra-precision grinding. The nano-scratches are obtained by a cube-corner tip under the two linear normal load conditions (0–30 mN and 0–60 mN). The normal force/scratch distance-penetration depth curves and the characteristics of chip and crack are analyzed to understand the transition mechanism of ductile to brittle removal. The results revealed that the deformation behavior of three regions exhibits plastic deformation, the transition from plastic to brittle deformation, and brittle deformation, respectively. The stress change rate has significant variations in the brittle-ductile transition zone. The critical ratio between mean contact pressures and hardness in the transition region is determined as 0.39 and 0.21, respectively.

Subsurface damage (SSD) is inevitably generated during the grinding process of quartz glass. It has a great impact on the sustainability, lifetime and optical performance of quartz glass components and systems. A PLS system was built to detect SSD in ground quartz glass samples prepared with different abrasive particle sizes. The PLS detection signal value had a positive correlation with the SSD depth. The finite-difference time-domain (FDTD) method was used to simulate the laser scattering process at the SSD. The electric field strength distribution may reflect the location of SSD. It is concluded that the PLS system can effectively detect SSD in the fused silica ground glass.

Silica glass is widely used as an optical lens material owing to its excellent optical properties and low thermal expansion coefficient. An optimal picosecond laser machining path is proposed to prevent the graphitization of diamond tools and improve the concentricity of tool cutting. This results in a multi-edge milling tool with a minimum rotary/turning diameter of 0.4 mm. The effect of rake angle on cutting force and the degree of brittle damage on the fused silica surface are studied by micro-milling tests of fused silica using laser-shaped tools. The results show that the fused silica machined by a diamond milling tool with a rake angle of -30° has the best surface finish (Ra = 41.2 nm). Using this laser-machined milling tool, a plurality of micro-Fresnel lenses with an aperture of 1.6 mm were successfully machined on a quartz glass plate.

The spacer rings are a key component of double-row roller bearings; therefore, the characteristics and properties of the spacer rings have a significant impact on the bearing functions. However, due to the lack of characteristics and performance analysis of the spacer ring, the means of improving bearing performance is limited. To analyze the characteristics of spacer rings and establish a basis for improving their performance, a new testing method for the characteristics and performance of the spacer ring was presented and corresponding experiments were developed. The test procedure entails the evaluation of basic characteristics, surface properties, and serviceability. This study contributes to establishing the testing and evaluation criteria for the performance of spacer rings in engineering, which helps in improving the performance of bearings.

In a nutshell, as a special material with a wide range of application potential, the preparation and performance research of new optical ceramic material is a major challenge. The future development trend is to continuously improve and optimize the manufacturing process and performance research in order to better meet the requirements of practical application and advance the technical application and industrialization of optical ceramic materials.

Author contributions

JG: Writing–original draft. ZT: Writing–review and editing. CW: Writing–original draft. QB: Writing–review and editing. YZ: Writing–review and editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.