

PROCEEDINGS

Research on Fracture Properties of Functional Ceramics Based on Digital Holographic Photoelasticity

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ABSTRACT

Functional ceramics, known for their excellent properties, are widely utilized in various fields, including electronics, energy, medicine, and aerospace. However, their inherent brittleness remains the Achilles' heel of all ceramic materials, posing challenges in practical applications. Consequently, accurately assessing the toughness of ceramic materials and exploring effective methods for its improvement has become a significant topic of current research [1,2]. Although numerous methods exist for measuring the fracture toughness of materials, these approaches often have limitations, particularly when applied to brittle materials. Conventional measurement techniques frequently struggle to simultaneously meet multiple requirements, such as detection precision, accuracy, and full-field detection. To address these limitations, this thesis employs the digital holographic photoelastic technique to conduct an in-depth study of magnesium oxide ceramic materials, achieving measurement accuracy at the nanometer level and enabling full-field internal stress measurement. This study investigates the application of digital holography in investigating fracture problems of the ceramic material magnesium oxide under three-point bending fracture experiments. A digital holographic optical path system was constructed for this purpose [3]. Three-point bending experiments were performed on magnesium oxide samples using the system, with holograms of the specimens recorded both before and after the application of loads. By utilizing the angular spectrum diffraction reconstruction algorithm, we obtained the complex amplitude of the object wave under varying load conditions and computed the phase changes of the object wave corresponding to different loads. Subsequently, we derived interference fringes from these phase changes, enabling the measurement of the stress intensity factor of magnesium oxide through holographic interferometry and plane stress theory. A comparison of the experimental measurements with theoretical values demonstrates that digital holographic technology is a viable method for measuring the stress intensity factor of ceramic magnesium oxide.

KEYWORDS

Digital holographic photoelasticity; ceramic materials; stress intensity ratio; fracture toughness

Acknowledgement: We gratefully acknowledge the support from the National Natural Science Foundation of China (Grant No. 12162017).

Funding Statement: This work was supported by the National Natural Science Foundation of China (Grant No. 12162017).



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Conflicts of Interest: The authors declare no conflicts of interest to report regarding the present study.

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