Comparison of Zirconia Toughened Alumina Fracture Toughness Obtained from Vickers Indentation by Applying Various Equations

By: Roslan, A (Roslan, Alida)[1]; Manshor, H (Manshor, Hanisah)[2]; Azhar, AZA (Azhar, Ahmad Zahirani Ahmad)[1]

MATERIALS CHARACTERIZATION USING X-RAYS AND RELATED TECHNIQUES
Edited by: Sulaiman, MA; Ahmad, ZA; Mohamed, JJ
Book Series: AIP Conference Proceedings
Volume: 2068
Article Number: UNSP 020004
DOI: 10.1063/1.5089303
Published: 2019
Document Type: Proceedings Paper

Conference

Conference: International Conference on X-Rays and Related Techniques in Research and Industry (ICXRI)
Location: Kota Bharu, MALAYSIA
Date: AUG 18-19, 2018
Sponsor(s): Univ Malaysia Kelantan; X Rays Applicat Soc Malaysia

Abstract

Alumina ceramics (Al2O3) displays excellent mechanical properties highly demanded in various fields of application. However, low fracture toughness (K-IC) property of the alumina ceramics limits their functionability such as heavy-duty forming tools and refractories. Adding a second composition, yttria stabilized zirconia was aimed to improve the K-IC property of alumina ceramics, producing a zirconia toughened alumina (ZTA) ceramics composite. Vickers indentation technique was employed in this work to determine the hardness and K-IC of ZTA ceramics as it requires only a small area of samples surface to be tested and is cost effective. ZTA ceramic composite was indented with 1 kgf load, three indentations each. The average hardness from the Vickers hardness testing of ZTA was recorded and the crack length was measured using scanning electron microscope (SEM). There is a wide variety of empirical equations available to determine the K-IC for Vickers hardness test, however most of the equations are said not to be in a good agreement with the K-IC value obtained from three point bending test. Thus, hardness and crack length parameters were incorporated in the various empirical equations available to measure the fracture toughness value. It was shown that the crack propagation follows Palmqvist model, and Eq.4 (K-IC=0.0134 (E/H-v)(1/2) (P/c(3/2))) is the most suitable in determining the K-IC of ZTA.

Author Information

Reprint Address: Manshor, H (reprint author)

+ Int Islamic Univ Malaysia, Kulliyyah Engn, Dept Sci Engn, POB 10, Kuala Lumpur 50728, Malaysia.

Addresses:

+ [1] Int Islamic Univ Malaysia, Kulliyyah Engn, Dept Mfg & Mat, POB 10, Kuala Lumpur 50728, Malaysia

+ [2] Int Islamic Univ Malaysia, Kulliyyah Engn, Dept Sci Engn, POB 10, Kuala Lumpur 50728, Malaysia

E-mail Addresses: alida_adila93@yahoo.com; hanisahmanshor@iium.edu.my; zahirani@iium.edu.my

Funding

Funding Agency	Grant Number
International Islamic University Malaysia	RIGS17-100-0675

View funding text

Publisher

AMER INST PHYSICS, 2 HUNTINGTON QUADRANGLE, STE 1NO1, MELVILLE, NY 11747-4501 USA

Categories / Classification

Research Areas: Materials Science; Physics

Web of Science Categories: Materials Science, Multidisciplinary; Materials Science, Characterization & Testing; Physics, Applied

See more data fields

Cited References: 11

Showing 11 of 11 **View All in Cited References page** *(from Web of Science Core Collection)*

1. **The Vickers hardness value of zirconia toughened alumina** — **Times Cited: 1**
   Group Author(s): Astro Met, Inc. an Advanced Ceramics Solutions
   VICK HARDN VAL ZIRC
   Retrieved from

2. **Zirconia-Physical and mechanical property comparison of the different types of zirconias** — **Times Cited: 1**
   Group Author(s): Azo Materials
   ZIRC PHYS MECH PROP Published: 2001
   Retrieved from

3. **Crack opening profiles of indentation cracks in normal and anomalous glasses** — **Times Cited: 65**
   By: Burghard, Z; Zimmermann, A; Rodel, J; et al.
   ACTA MATERIALIA Volume: 52 Issue: 2 Pages: 293-297 Published: JAN 19 2004

4. **Wear behaviour of alumina toughened zirconia materials** — **Times Cited: 18**
   By: Cherif, K; Gueroult, B; Rigaud, M
   WEAR Volume: 199 Issue: 1 Pages: 113-121 Published: NOV 1 1996

5. **Evaluation by Vickers indentation of fracture toughness of a phosphate biodegradable glass** — **Times Cited: 15**
   By: Clement, J; Torres, P; Gil, FJ; et al.
   JOURNAL OF MATERIALS SCIENCE-MATERIALS IN MEDICINE Volume: 10 Issue: 7 Pages: 437-441 Published: JUL 1999

6. **Zirconia toughened alumina ceramic foams for potential bone graft applications: fabrication, bioactivation, and cellular responses** — **Times Cited: 38**
   By: He, X.; Zhang, Y. Z.; Mansell, J. P.; et al.
   JOURNAL OF MATERIALS SCIENCE-MATERIALS IN MEDICINE Volume: 19 Issue: 7 Pages: 2743-2749 Published: JUL 2008

7. **Determination of fracture toughness using the area of micro-crack tracks left in brittle materials by Vickers indentation test** — **Times Cited: 33**
   By: Moradkhani, Alireza; Baharvandi, Hamidreza; Tajdari, Mehdi; et al.
   JOURNAL OF ADVANCED CERAMICS Volume: 2 Issue: 1 Pages: 87-102 Published: MAR 2013

8. **Indentation brittleness of ceramics: A fresh approach** — **Times Cited: 310**
   By: Quinn, JB; Quinn, GD
   JOURNAL OF MATERIALS SCIENCE Volume: 32 Issue: 16 Pages: 4331-4346 Published: AUG 15 1997

9. **Fracture toughness modification by using a fibre laser surface treatment of a silicon nitride engineering ceramic** — **Times Cited: 18**
   By: Shukla, P. P.; Lawrence, J.
   JOURNAL OF MATERIALS SCIENCE Volume: 45 Issue: 23 Pages: 6540-6555 Published: DEC 2010

10. **Fracture toughness evaluation of Al2O3/TiC+TiN tool composite by means of controlled Vickers crack growth** — **Times Cited: 4**
    By: Szutkowska, M; Boniecki, M
    JOURNAL OF MATERIALS SCIENCE LETTERS Volume: 22 Issue: 23 Pages: 1719-1721 Published: DEC 1 2003

11. **APPLICATION OF INDENTATION TECHNIQUE IN DETERMINING FRACTURE-TOUGHNESS OF CERAMICS** — **Times Cited: 1**
    By: XIA, SB; LI, GX; LI, CC
    ENGINEERING FRACTURE MECHANICS Volume: 31 Issue: 2 Pages: 309-313 Published: 1988

Showing 11 of 11 **View All in Cited References page**