



## Indentation of a Melt-Quenched Zeolitic Imidazolate Framework Glass

Stepniewska, Malwina; Januchta, Kacper; Zhou, Chao; Winther, Grethe; Smedskjær, Morten Mattrup; Yue, Yuanzheng

*Publication date:*  
2018

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Stepniewska, M., Januchta, K., Zhou, C., Winther, G., Smedskjær, M. M., & Yue, Y. (2018). *Indentation of a Melt-Quenched Zeolitic Imidazolate Framework Glass*. Abstract from International Commission on Glass Annual Meeting 2018, Yokohama, Japan.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# Indentation of a Melt-Quenched Zeolitic Imidazolate Framework Glass

Malwina Stepniewska<sup>1</sup>, Kacper Januchta<sup>1</sup>, Chao Zhou<sup>1</sup>, Grethe Winther<sup>2</sup>, Morten M. Smedskjaer<sup>1</sup> and Yuanzheng Yue<sup>1</sup>

<sup>1</sup>Department of Chemistry and Bioscience, Aalborg University, DK-9220 Aalborg, Denmark

<sup>2</sup>Department of Mechanical Engineering, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark

Recently, a new family of melt-quenched glasses has emerged, namely, the melt-quenched zeolitic imidazolate framework (MQ-ZIF) glasses [1, 2]. Despite several breakthroughs in understanding the nature of these glasses, their mechanical properties have not been well characterized and understood, such as ultrahigh Poisson's ratio [2]. Indentation is a sensitive method for revealing the deformation mechanism and crack propagation of glasses [3, 4]. The nano-indentation has proven to be especially useful in characterization of glass materials with limited size, e.g., glass fibers [5].

In this work, we employed both micro- and nano-indentation to characterize the deformation mechanism of the MQ ZIF-62 ( $\text{Zn}(\text{Im})_{1.75}(\text{bIm})_{0.25}$ ) glasses. Vicker's micro-indentation was performed at various loads to assess the scaling effect's influence on hardness, fracture behavior, and indent morphology. Cross-sections of the indents were analyzed to reveal the deformation mechanism and the sub-surface cracking pattern. Nano-indentation studies were conducted to compare nano- and microscale behavior of the samples. The load-displacement curves were used to analyze the elastic and permanent deformation during indentation. Nanoindents were characterized by Atomic Force Microscopy to evaluate the volume of the indent and pile-up pattern, and determine the contribution of the shear flow to indentation-induced deformation of MQ ZIF-62. The deformation mechanism and cracking pattern are found to be similar to those of the fully polymerized oxide glasses like fused silica [4], yet the pile up is minimal. This implies that shear flow has little contribution to the indentation-induced deformation of ZIF-62 glass.

## References

- [1] T.D. Bennett, et al., *Nat. Commun.*, 6 (2015) 1–7.
- [2] A. Qiao, et al., *Sci. Adv.*, 4 (2018) eaao6827.
- [3] S. Yoshida, et al., *J. Mater. Res.*, 20 (2005) 3404–3412.
- [4] T. Rouxel, et al., *J. Appl. Phys.*, 107 (2010) 094903.
- [5] N. Lonroth, et al., *J. Non-Cryst. Solids*, 354 (2008) 3887–3895.