Synthesis and Glass Forming Ability of Several Dual-Metallic Zeolitic Imidazolate Frameworks

Stepniewska, Malwina; Zhou, Chao; Yue, Yuanzheng

Synthesis and Glass Forming Ability of Several Dual-Metallic Zeolitic Imidazolate Frameworks

Malwina Stepniewska*, Chao Zhou, Yuanzheng Yue

Department of Chemistry and Bioscience, Aalborg University, DK-9220 Aalborg, Denmark

*Corresponding author. E-mail: mst@bio.aau.dk

Zeolitic Imidazolate Frameworks have attracted attention of scientists. Their excellent thermal and chemical stability shows a vast range of potential applications in many fields. In the last two years, melt quenched ZIF glasses have been emerging, yet for this group of materials we still lack understanding of many observed phenomena such as glass formation, polyamorphic transition, melting behavior [1-3].

To gain a better understanding of glass formation, we change the chemical composition of samples during synthesis. For this study, we focus on ZIF-62, characterized by high thermal stability and particularly good glass formability. This particular framework is made of Zinc ions connected by two kinds of ligands (Imidazole and benzimidazole). The first step was to choose the ligand ratio allowing us to generate the crystals with optimum size and yield. The second step was to substitute the second type of metal nodes (cobalt, copper, manganese, iron) for the first metal in the structure. We introduced initially from 10% to 90% of second metal into the structure. By changing the ratio between the two metallic nodes we produced dual-metallic ZIFs by solvothermal synthesis. SEM observations and laser diffraction particle size analysis were conducted to study the metal ratio dependence of the shape and size of the obtained crystals. XRD measurements were performed to detect the structural change of the crystals. DSC measurements were conducted to determine the glass transition temperature, melting temperature and the glass forming ability, while the thermogravimetry is used to detect the mass change during heating. Through this study, we provide insight into glass formation of ZIFs in terms of the influence of the chemical composition (both the ligands and the metallic nodes) on the dynamic and thermodynamic properties.

References:

[1] Bennett, T. D.; Tan, J.-C.; Yue, Y.; Baxter, E.; Ducati, C.; Terrill, N. J.; Yeung, H. H.-M.; Zhou, Z.; Chen, W.; Henke, S.; et al. Hybrid Glasses from Strong and Fragile Metal-Organic Framework Liquids, Nat. Commun. 2015, 6, 8079.

[2] Bennett, T. D.; Yue, Y.; Li, P.; Qiao, A.; Tao, H.; Greaves, G. N.; Richards, T.; Lampronti, G. I.; Redfern, S. A. T.; Blanc, F.; et al., Melt-quenched glasses of metal-organic frameworks, J. Am. Chem. Soc. 2016, 138 (10), 3484–349.

[3] Tao, H. Z.; Bennett, T. D.; Yue, Y. Z., Melt-Quenched Hybrid Glasses from Metal-organic Frameworks, Adv. Mater. 2017, DOI: 10.1002/adma.201601705.