Structural and mechanical properties of hybrid silica aerogel formed using triethoxy(1-phenylethenyl)silane

Haryeong Choi, **Taehee Kim, Younghun Kim, Rushikesh P. Dhavale and Hyung-Ho Park***
Department of Materials Science and Engineering, Yonsei University, Seoul 03722, Republic of Korea

*Corresponding Author: hhpark@yonsei.ac.kr
Email address of the presenting author: haryeong@yonsei.ac.kr

ABSTRACT

Silica-based aerogels possess extremely low density, low thermal conductivity, high porosity, and high surface area due to the nanopore distribution. Until now, the commercialization of silica-based aerogels has been restricted due to their brittle nature, and this drawback needs to be overcome by the improvement in the mechanical properties. A synthesis of doubly crosslinked aerogels using radical polymerization and hydrolytic polycondensation was reported to enhance the mechanical properties. Therefore, for the first time, the silane-based precursor triethoxy(1-phenylethenyl)silane (TPS) was introduced to synthesize the hybrid organic-inorganic aerogels in this research. The simple, fast, and cost-effective free radical polymerization method was adopted to prepare TPS precursor. In present work, the tetraethylorthosilicate (TEOS) and TPS were introduced together at different molar ratios followed by hydrolysis-condensation and supercritical CO_2 drying to achieve hybrid aerogels. The hybridization between TEOS and PTPES can enhance the degree of hydrophobicity to ~120° when compared with the native silica aerogel. The physical as well as textural properties were well controlled by varying the mole percentage of silane compound up to 5 mol%. The organic hybridized aerogels showed high specific surface areas (520–900 m^2/g), high pore volumes (16.5–34.5 cm^3/g), low densities (0.03–0.05 g/cm^3), and a high degree of hydrophobicity (120°). Furthermore, mechanical properties such as compressive toughness was 10-fold higher in the organic-inorganic hybridized aerogels. These aerogels have potential candidate in thermal insulation application. The remarkable increase in the mechanical strength and hydrophobicity was found in the phenyl/vinyl hybridized aerogels compared with pristine silica aerogels. This facile synthesis approach provides new method to decorate the organic-inorganic hybrid aerogels.

Keywords: polytriethoxy(1-phenylethenyl) silane; organic-inorganic hybridized aerogel; mechanical properties; CO_2 supercritical drying.

Acknowledgement: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government(MSIT) (No. 2020R1A5A1019131). This work was supported by the Human Resources Development program (No. 20204030200110) of the Korea Institute of Energy Technology Evaluation and Planning(KETEP) grant funded by the Korea government Ministry of Trade, Industry and Energy.

References

[1] H. Choi, V. Parale, T Kim, Y. Choi, J. Tae, H. Park, Micro. Meso. Mater. 298 (2020) 110092.
[2] K. Kanamori, M. Aizawa, K. Nakanishi and T. Hanada, Adv. Mater., 19 (2007) 1589.
[3] G. Hayase, K. Kugimiya, M. Ogaw, Y. Kodera, K. Kanamori and K. Nakanishi, J. Mater. Chem. A, 2 (2014) 6525.