PREPARATION AND PROPERTIES OF CONDUCTIVE FOAMS VIA HIGH INTERNAL PHASE EMULSION

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ABSTRACT

A high internal phase emulsion (HIPE), in which the volume fraction of the dispersed phase is higher than the maximum packing volume fraction, forms a polyhedral thin film structure by contacting droplets. The HIPE can be utilized as a template for fabricating microporous structures. When the continuous phase is a monomer, polymerization of the emulsion followed by removal of the dispersed phase results in a microporous foam. The open-cell structure of polyHIPE is formed because the thermodynamically unstable thin film is easily broken, allowing the cells to connect to each other. The cell size of polyHIPE can be controlled by agitation, solvents, emulsifiers, and polymerization conditions. This foam can be used in various fields such as gas storage media, polymer membranes, ion exchange resins, catalyst supports, shape memory resins, tissue engineering scaffolds, and supercapacitor electrode materials. In this study, electrically conductive polystyrene/carbon nanotube (CNT) microporous foam was fabricated using HIPE as a template. CNTs were modified with polypyrrole (PPy), a conducting polymer, to increase chemical affinity with the oil phase of HIPE and improve electrical conductivity of the microporous foam. The effect of PPy-modified CNT (PPy-CNT) was evaluated in terms of rheological properties, morphology and electrical conductivity. The addition of PPy-CNT had a significant effect on the rheological properties of HIPE and the electrical and mechanical properties of polyHIPE. As the PPy-CNT content increased, the yield stress and storage modulus of the emulsion increased, gradually exhibiting solid-like properties. In addition, as the PPy-CNT content increased, the cell size of the microporous foam decreased, and the electrical conductivity and crush strength increased.

REFERENCES

1. Silverstein, M. S. PolyHIPEs: Recent advances in emulsion-templated porous polymers, *Prog. Polym. Sci*., **39**, 199–234, 2014.
2. Kim, H.; Ahn K. H.; Lee, S. J. Conductive poly(high internal phase emulsion) foams incorporated with polydopamine-coated carbon nanotubes, *Polymer*, **110**, 187–195, 2017.
3. Lee, S. H.; An, J. H.; Kim, Y. J.; Lee, S. J. Electrically conductive foams from high internal phase emulsions with polypyrrole-modified carbon nanotubes: Morphology, properties, and rheology. *Polymer*, **242**, 124600, 2022.