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M1Po3D-02: Formation of thermal conductive hydrogel network in boron nitride/polyvinyl alcohol by directional freezing assisted salting-out method for cryogenic application

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Polymers play a crucial role as packaging materials for flexible electronic devices. Along with the rising power of electronic components, enhancing the thermal conductivity of hydrogel materials can greatly improve the performance of flexible electronic components. Herein, we designed a hydrogel material composed of polyvinyl alcohol (PVA) doped with 500nm boron nitride nanosheets (BNNS), which was prepared by directional freezing assisted salting. The directional porous structure was confirmed via scanning electron microscopy, while the mechanical properties and thermal conductivity were validated by universal tensile test and steady-state thermal conductivity measurement respectively. The thermal conductivity of this material reaches 0.65 W/m·K at room temperature, and the tensile strength achieves 513.4 kPa. Besides, the thermal conductivity can still reach 0.32 W/m·K at the temperature of 77K. Therefore, the material is capable of enhancing heat dissipation in the packaging of flexible electronic devices, both in room and cryogenic environment. In addition to being an encapsulation material for flexible devices, the material is also able to form a three-dimensional BN skeleton, which can be subsequently injected into epoxy resin to prepare epoxy composite with enhanced thermal conductivity. The thermal conductivity of the epoxy composite is up to 0.82 W/m·K at room temperature and 0.38 W/m·K at the temperature of 77K respectively. Due to the heat conduction network constructed by the skeleton structure, the thermal conductivity of epoxy composite is improved. In our work, a flexible hydrogel with improved thermal conductivity was constructed by means of directional freezing assisted salting out. The hydrogel and its derivatives are expected to be applied in the field of low temperature electronic packaging in the future.

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