

Heterostructured Polymer-Infiltrated Nanoparticle Films via Capillary Rise Infiltration and Their Application as Bragg Reflector Sensors

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Polymer-infiltrated nanoparticle films (PINFs) that have high volume fractions (> 50 vol %) of nanoparticles (NPs) are a unique class of nanomaterials. To achieve scalable fabrication of PINFs in a simple manner, capillary rise infiltration (CaRI) and solvent-driven infiltration of polymer (SIP) into densely packed NP films have been introduced as versatile techniques. However, these techniques are only ideal for fabricating PINFs with homogenous structure that has limited applicability in separations and photonic/optical coatings. In this work, we present a new technique for fabricating heterostructured PINFs based on CaRI. A bilayer composed of densely packed inorganic NP layer atop a polymer NP layer is formed and then thermally annealed above the glass transition temperature of the polymer NP. Upon annealing, CaRI of the polymer into the interstices of the inorganic NP layer occurs, resulting in heterostructured double stack PINFs composed of a PINF and a layer with large cavities. Taking advantage of a large refractive index difference of these two layers, we fabricate Bragg reflector sensors by stacking multilayers of the double stack PINFs.