Abstract

In this work, a novel and sustainable paper template-based method was developed for the preparation of advanced niobium carbide (NbC)-based free-standing films for electromagnetic interference (EMI) shielding application. By employing the porous structure of paper template, the simultaneous optimization of thickness, flexibility, overall weight as well as shielding effectiveness (SE) of NbC-based free-standing films were facilely achieved. The pyrolytic carbon (PyC) derived from cellulose in paper was employed as carbon source for the growth of the NbC phase. A hierarchically porous structure with porosity of as high as ~80 % was established to optimize the flexibility and low density of the resultant films. Adjusted heterogeneous NbC-PyC nano-interfaces were formed through controlling the amount of NbC and remaining PyC phase in the NbC-based foams, which significantly improved the absorption capability of EM waves. At the highest NbC content, the film exhibited an EMI SE of 50 and 86 dB at a sample thicknesses of ~55 and ~220 μm, respectively compared to 32 dB of pristine paper derived PyC film (~55 μm thickness). The obtained composite unambiguously indicates the high potential of NbC as a promising EMI shielding material. These results provide guidance for the design of other advanced transition metal carbides (TMCs) based EMI shielding materials and to explore more eco-friendly and commercially effective routes for the recycling of used paper through developing their application in the EM field.

Keywords: Paper template, Niobium carbide, flexible, electromagnetic shielding