Graphene Composites for Lightweight EMI Shielding

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Electromagnetic interference (EMI), the conduction or induction of unwanted electromagnetic (EM) signal into a circuit, is a pervasive problem in modern electronics [1]. Devices improperly shielded against EMI have poor circuit reliability [1]. Depending on application, the failure of a key circuit and surrounding hardware can create financial and safety concerns, especially in aerospace and telecom[1-4]. As flexible, stretchable, and lightweight technology is developed, novel materials to protect from EMI effects are necessary. The current standard for shielding (Cu, Ni, Al [1]) cannot fulfil these requirements due to incompatibility with stretchable substrates, primarily reflective EMI shielding, and their high density (Cu ~9 g/cm^3) compared with polymeric composites (<1 g/cm^3). Polymer composites with conductive additives provide an alternative solution [1,5-11]. Due to its high aspect ratio, broadband absorption, and good conductivity, graphene is a candidate as an absorbent filler in these composites [5-9]. Ref.[11] reported graphene foam (GF)/polymer composites with low density (<19mg/cm^3)[10], and EMI shielding effectiveness (SE, measured in dB as the signal power attenuation)>90dB [10], with a specific shielding effectiveness (SSE, i.e. SE divided by density)~3124 dB•cm^3/g [10]. However, the production of these composites is expensive due to the one time use of Ni foams [10-11], and time consuming due to CVD and multi-step processing[10-11]. Here we present EMI absorptive (>90%) graphene foam (GF)/polymer composites by exploiting inks produced by microfluidization in conjunction with lyophilization [12]. The effects of different binders, binder loading, directional freezing, and foam density on EMI attenuation over the X-band (8.2-12.4 GHz) are studied. We obtain densities~10-100 mg/cm^3, with pore size~10 μm [Fig. 1], with conductivities and EMI SE ~13 S/m and up to 67dB [Fig. 2], with SSE up to 1000dB•cm^3/g for free standing GF, and ~100dB•cm^3/g for GF/PDMS, >10 times greater than Cu-based SSE[1]. Thus, our composites are effective, absorbent EMI shielding alternatives to current technology.

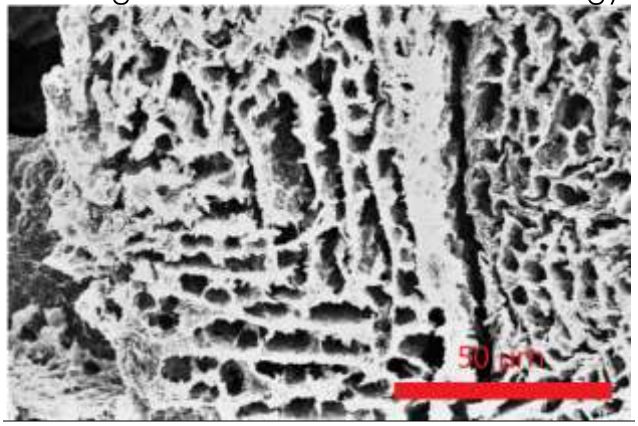

Figure 1: SEM of graphene foam cross section.

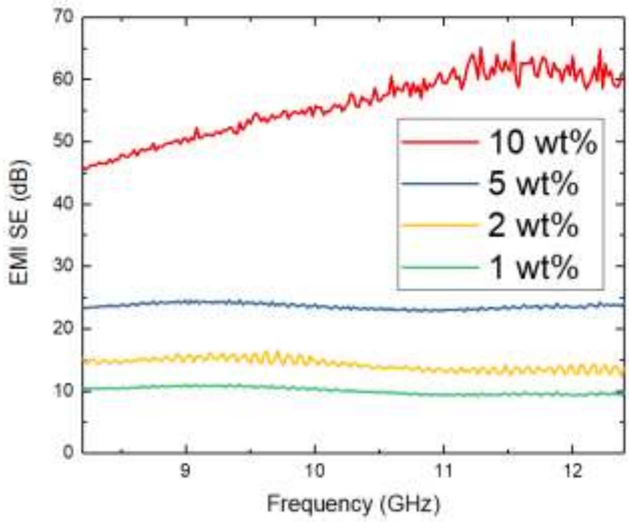

Figure 2: EMI SE of PDMS/GF composite across the X-band(8-12GHz) for GF weight percent.

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