URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

Optically Transparent EMI Shielding Nanocomposite for X band

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There are several areas where electromagnetic shielding is critical, especially, with advances in electronics most of the gadgets need protection from EMI interference. While there is lot of work being carried out in composites for EMI shielding, there is a need for optically transparent and EMI shielding in microwave for applications such as windows, touch screens, displays etc. This is more challenging since apart from EMI shielding there is a requirement of material with optical transparency and sometimes flexibility also. Among the materials which are used for such applications where optical transparency and EMI shielding in microwave is required, Indium Tin Oxide is the most commonly used material as coating. There are certain disadvantages of ITO like its brittleness, cost considerations as the cost of Indium is ever increasing, and being conducting material the EMI shielding due to this material is reflection based and there is no component of absorption in it which could be a disadvantage for certain application. This forces researchers to reconsider this material for such applications [1].

A reasonable combination of conductivity, permittivity and permeability is a key to development of such materials having both optical transparency and absorption in microwave. Search for such material is an ongoing process. Presently, optical transparency and EMI shielding is achieved using metal mesh yielding SE of more than 60dB. But this technology has a drawback of high cost, complicated manufacturing required etc. Therefore, different solutions from nanotechnology are being sought for this application. Nanocomposites are one of the ways in which one tries to achieve such properties. The requirement of nanofillers for such applications are quite well known now. EMI shielding mainly relies on conductivity, permeability and impedance matching between incoming wave and the material which and therefore it also depends on the combination of permittivity and permeability. A material with reasonable conductivity which can provide pathways for the electron to travel in a composite as filler along with ferrites which can provide permeability can enhance the shielding efficiency due to absorption. EMI shielding due to absorption increases with thickness of the film which in this case cannot be done since it decreases the optical transparency of the film. In our previous publications [2] we have shown that graphene nanoribbons can be a very good option of EMI shielding with requirement of very small wt % of the nanofiller.
Optically transparent films of nanocarbon materials, namely Carbon nanotubes and graphene nanoribbons and their ferromagnetic nanocomposites with Fe_3O_4 and Cobalt in PVA-PEDOT matrix were made to be used for microwave absorption (X-band), in order to obtain shielding efficiency. As seen in the recent works on transparent shielding materials, achieving high shielding efficiency along with optical transparency is pretty hard and till now not very high values of the same have been achieved even with metallic materials like silver nanowires. Hence, a combination of films with varying thicknesses of 0.4, 0.8, 1.2 mm and varying concentrations of 0.1wt percent and 0.5wt percent of nanocarbon/nanocarbon ferromagnetic nano-filler in the polymer matrix were compared for EMI shielding efficiency. It was observed that transparency was compromised as the thickness was increased but better shielding efficiency was obtained for the same. The highest shielding effectiveness for transparent films were seen for CNT-Co (0.5 wt%) at -13.19dB with 76.32% transmittance and for GNR- Fe_3O_4 at -14.72dB for 0.5wt percent with 79.8% transmittance Thicker films gave maximum EMI shielding efficiency for Graphene Nanoribbon-Cobalt composite at -17.55dB for 0.5wt percent and for CNT-cobalt of -16.59dB for 0.5wt percent for 1.2mm thick film. But there was very little transparency left for such thick films.

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