Grafen/CNT doped polymer based nano composites: RF Shielding properties of the nano composite coated fabric materials

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Graphene nanopowders and carbon nanotubes (CNTs) are widely synthesized and used to design new electromagnetic interferences (EMI) shielding materials to avoid of the electromagnetic pollution, which increases sharply with unavoidable development of electronics technology [1-2]. EMI can be defined as conducted and/or radiated electromagnetic signals emitted by electrical circuits which, under operation, perturb proper operation of surrounding electrical equipment or cause radiative damage to living/biological species. More generally, electromagnetic shielding is also defined as the prevention of the propagation of electric and magnetic waves from one region to another by using conducting or magnetic materials. The shielding can be achieved by minimizing the signal passing through a system either by reflection of the wave or by absorption and dissipation of the radiation power inside the material [3].

In the present study, the state-of-the-art research was realized in design and characterization of polymer/carbon based composites as nanostructured EMI shielding materials. The newly designed nanographene/CNT doped polymer gels were applied on the fabric substrates (ST, SG, etc. coded) by using spray coating method. The measurements (to determine electromagnetic shielding effectiveness) were performed according to ASTM D4935-10[4]. The prepared materials (before and after the coating) were also structurally investigated in molecular, nanoscopic and microscopic scales by using several complementary experimental (FTIR, WAXS, SAXS, SEM) methods. The obtained form factors which are related to core-shell cylinder and fractal models were used in nanoscale SAXS analyses (Fig.1) to characterize the morphologies, sizes and distributions. Graphen and CNT doping with percentage of 4% shows the comparative results for the layered coatings and EMI Shielding. Mono/multi layer applications of the newly designed nanomaterials on fabrics were also investigated to develope EMI shielding effectiveness. Multilayered topologies are commonly used as liners for all enclosures in which reflection, absorption of waves has to be minimized.

The focused studies were increasing the surface area of the nanoparticles and reaching the stabilized monodispersed morphologies and arbitrarily oriented uniform distributions. So the nanoparticle doped polymer matrix coated nanomaterials may behave such as conductive networks against to incident signals. As increasing reflectivity and absorbance results may cause better shielding efficiency.

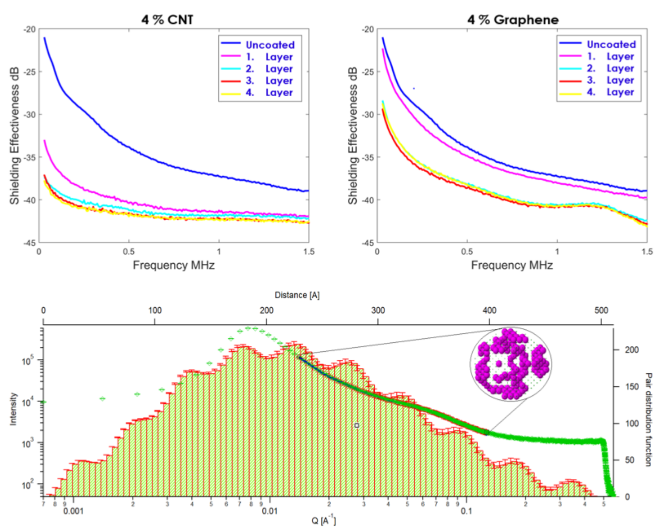

Figure 1. Shielding Effectiveness of 4% Graphene and 4% CNT doped nanocomposite coating layers (Top), 3D, ab-initio structure (DAMMIN) model for %4 CN-ST sample, fitting curve and PDDs (Bottom)

As a result of the study, it was obtained that ellipsoidal fractal units come together to form larger and more compact core-shell oblate shaped nano aggregations. It was also shown that, the size, shape, and distribution-controlled synthesizing processes may be useful and possible to increase electromagnetic shielding effectiveness in the manner of absorption and reflection.

The aspect ratio of the graphene/CNT to polymer is a major parameter and is determinant for the studied samples. Graphene doping is respectively more efficient than that of CNT. The dispersion method is another important factor and must preserve the high aspect ratio of the doped nanomaterials as much as possible within the polymer. Especially, multilayer applications on fabric substrate make reasonably higher shielding effect because of the better surface coverage. With the further experimental works, more efficient results can be obtained with respect to metal doping inside the polymer, in the manner of corrosion, weight load, flexibility and easy application.

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