© 2018 IJSRST | Volume 5 | Issue 3 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Spectroscopic and Electromagnetic Interference-Shielding Effectiveness Studies on Polyaniline/DBSA/MoO_3 Composite at X-band Frequencies

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ABSTRACT

Nowadays, emerging research in the areas of conducting polymer-based metal oxide composites have shown much interest among modern physical and chemical researchers due to their unique absorption properties. In the present work, the conducting polyaniline/ molybdenum trioxide nanoparticles blended in DBSA was synthesized by in-situ polymerization technique with varied weight % (10, 20, 30, 40 and 50) of molybdenum trioxide. The analysis on the EMI Shielding Effectiveness (EMI-SE) of the synthesized samples in the X-band frequencies (8.2-12.4 GHz) is presented here. The influence of molybdenum trioxide nanoparticle in Polyaniline/DBSA matrix over the EMI-SE has been studied. It is observed that the synthesized composites exhibit excellent shielding efficiency in the entire range of X-band. The absorption governed shielding effectiveness of the synthesized polyaniline/DBSA/MoO_3 composite finds cost effective applications and manifests electromagnetic compatibility in the X-band frequencies.

Keywords: Polyaniline; DBSA; molybdenum oxide; EMI shielding; composites.

I. INTRODUCTION

Composites of conducting polymer – metal oxide nanoparticles are of great research interest for scientists due to their distinct physical and chemical properties viz., high conductivity, facile synthesis, light weight, flexibility and ease of processability [15]. Due to these properties, they have recently attracted much interest in practical application as broad band microwave absorbers and electromagnetic shielding screens [1-4]. The characteristic absorption properties in particular have many areas especially in the field of aerospace and military applications, where conductive composites studied so far have been relatively poor broad band performers and such composites appears to be one of the few materials capable of dynamic microwave absorption. Microwave absorbers have attracted greater importance because of their use in electronic devices and controlling the wave pollution [5]. Hence EMI-SE has therefore, become a matter of high priority.

II. METHODS AND MATERIAL

Doubly distilled aniline (1.0ml) monomer and 7.6 ml of dodecyl benzene sulphonic acid (DBSA) were mixed in 500 ml of milli-Q water with constant stirring. After 1hr, an aqueous solution (10ml) of 0.1mol ammonium persulfate (APS) was pour to the reaction mixture. The obtained solution was kept under magnetic stirring and over the period of 14 hr of reaction, the Molybdenum trioxide (MoO_3) is added

to the PANI/DBSA polymer matrix solution with constant stirring for 4-6 hrs at 0-5^{0}C in order to achieve homogeneous dispersion of MoO_3 in the polymer matrix. The precipitate so obtained was filtered off by successive washing with water and acetone. Finally, the so obtained precipitate was dried at 80^{0}C to gain constant weight. Following this procedure, PANI/DBSA/MoO_3 composites were prepared with different (10, 20, 30, 40 and 50wt%) of MoO_3 in PANI/DBSA matrix.

III. RESULTS AND DISCUSSION

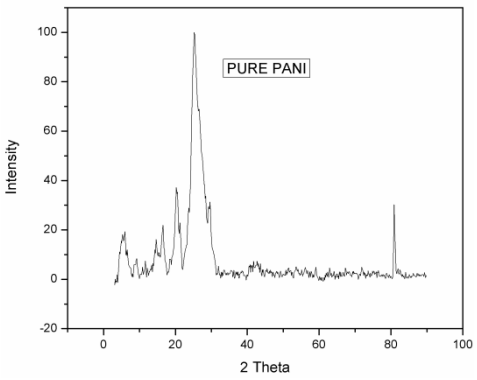
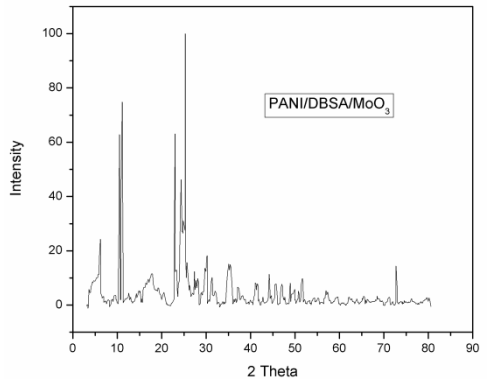


Figure 1a



Figurte 1b

Figure 1.shows XRD spectra of (a) pure PANI, (b) polyaniline/ DBSA/MoO_3 -50 wt %

XRD pattern clearly displays the broad peak at 2θ=27^0 indicating semi-crystalline behaviour of PANI with a crystallinity ranging from 10-30%, which is on par with the values reported by Yusoff A.N et.al. [9]. XRD spectra of polyaniline/DBSA/MoO_3-50% composite shows characteristic peaks corresponding to 2θ = 33.51^0, 56.04^0 and 67.05^0 ascribed to (010), (020), (030) planes of MoO_3. The sharp peaks observed in these pattern, reveal the crystalline nature of the MoO_3 particles. It is seen in the XRD pattern of these composites, the sharp peaks were well retained, clearly indicating the presence of MoO_3 particles and homogeneous distribution of these particles in the PANI/DBSA matrix. Thus, XRD results reveal that MoO_3 particle does not show morphological deformation upon incorporation with PANI/DBSA matrix during the polymerization process.

It is observed from the figure 2 that, there is a constant increase in observed EMI-SE of the synthesized composites with increased weight percentage of MoO_3. Here the higher shielding efficiency observed for the composites may be attributed to the higher interfacial area and the porous network provided by the MoO_3 in polyaniline/DBSA molecular chains. The movement between the electric and magnetic dipoles present in the composites can also cause the electromagnetic wave attenuation. Altogether, the synthesized polyaniline/DBSA/MoO_3 composites exhibit absorption shielding potency in the whole X-band [10-14].

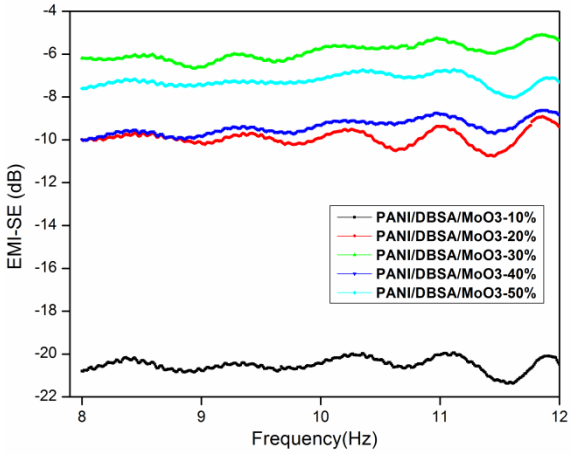


Figure 2

Figure 2. shows variation of EMI-SE with the frequency for polyanilne/DBSA/MoO_3 -10%,20%,30%,40%&50% composites in the X-band frequencies.

IV. CONCLUSION

In summary, the conducting polyaniline/DBSA/MoO_3 composites were prepared by in-situ polymerization technique using $(NH_4)_2S_2O_8$ as an oxidant. The EMI shielding effectiveness of these composites has been carried out with thickness varying from 1.9-2.0 mm over a range of X-band frequencies. These EMI-SE results show good EMI-shielding properties in the X-band frequencies. Intrinsically conducting three dimensional inter connected network of conducting PANI/DBSA acted as an effective matrix for the dispersed phase of MoO_3 particles, resulted in an effective morphological change to act as wave attenuation centres. As the concentrations of MoO_3 content increases in the PANI/DBSA matrix, the EMI-SE increases. The results reveal that, the composites show good EMI shielding characteristics and can be further optimized for EMI shielding applications.

V. ACKNOWLEDGEMENT

Authors wholeheartedly acknowledge VGST, for providing financial research grant vide (No.: VGST/K-FIST (L_1)/GRD-363/2014-15 dated 02/01/15).. We are also thankful to the Principal and Management of PESIT-BSC, Bangalore for their kind cooperation to carry out this research work.

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