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TITLE OF THESIS: MOLECULAR DESIGNING OF CONDUCTING POLYMERS BY DELIBERATE MODIFICATION IN THE MONOMER/POLYMER MATRIX FOR CORROSION AND EMI SHIELDING APPLICATIONS

ABSTRACT & FINDINGS

The objective of the work presented in this thesis is to study the electromagnetic (EM) shielding properties of the conducting polymer composites. In these types of composites, magnetic nanoparticles have been incorporated in the conducting matrix and the effects of these nanoparticles on the EM shielding properties of the composites have been studied. Motivation of the present work comes from the idea that in case of metal, EM shielding properties are derived from their high conductivity and mainly dominated by reflection. Whereas, in case of conducting polymers, due to their polar nature, the EM shielding is mainly governed by absorption and this absorption effect increases manifold after the addition of magnetic nanoparticles in these polymer.

A brief review about the doping, conductivity mechanism and various routes for synthesis of conducting polymers has been presented. Microwave absorbing magnetic materials with high resistivity such as ferrites has been discussed. Different phenomenon that contributed towards the shielding effectiveness of the material and the methods for the measurement of shielding and dielectric properties have been given. As the conductivity of the conducting polymer composites lies in the semiconducting range which depended on dielectric properties has also been included.

The synthesis of polyaniline (PANI) and polyaniline-SiO_2 composites (PSC) by chemical oxidation polymerization in the presence of phosphoric acid medium and evaluation of synthesized PANI and PSC for protection of mild steel from corrosion in a strong aggressive mediums (i.e.1.0 M HCl). Suitable coating with PSC was formed on mild steel using epoxy resin by powder coating technique. Comparative study of corrosion protection efficiency of mild steel coated PANI and PSC in 1.0 M HCl solution has been evaluated using Tafel extrapolation method, chronoamperometry and weight loss methods. The results reveal that the PSC coating

showed the significant reduction in the corrosion current density reflects the better protection of mild steel in acidic environment. Higher protection efficiency up to 99 % has been achieved by using PSC coated mild steel at 6.0 wt. % loading of PSC in epoxy resin. Coating performance and corrosion rate of mild steel has been investigated by using immersion of polymer coated mild steel in 1.0 M HCl for 60 days indicating that PSC coated mild steel revealed better performance from corrosion as compared to PANI in acidic medium.

The synthesis of hydrophobic polyaniline-SiO_2 composite (HPSC) by chemical oxidation polymerization by using fluorinated dopant i.e. perfluoro-octanoic acid (PFOA). HPSC coating were evaluated for protection of mild steel from corrosion in 3.5 % NaCl aqueous solution. Suitable coating with HPSC was formed on mild steel using epoxy resin by powder coating technique. Hydrophobic properties of HPSC were investigated by contact angle measurement. Corrosion protection efficiency of mild steel coated HPSC in 3.5 % NaCl aqueous solution has been evaluated using Tafel extrapolation method, salt spray test and weight loss methods. The results reveal that the HPSC coating showed the significant reduction in the corrosion current density reflects the better protection of mild steel in marine environment. Protection efficiency of the coating containing HPSC was 93.3 % in 3.5 % NaCl solution after 60 days of immersion and 85 % in the salt spray test of 35 days. The high performance of HPSC containing coating is attributed to the passivation of steel by polyaniline. Higher protection efficiency up to 96 % has been achieved by using HPSC coated mild steel at 6.0 wt. % loading of HPSC in epoxy. Coating performance and corrosion rate of mild steel has been investigated by using immersion and salt spray test indicating that HPSC coated mild steel revealed better performance from corrosion.

deals with the synthesis of conducting ferromagnetic Polyaniline-Ti doped Fe_2O_3 nanocomposite and investigates the effect of Ti doped Fe_2O_3(FT) nanoparticles on the shielding properties of the polyaniline composites. For this, initially, the FT nanoparticles were synthesized using chemical co-precipitation of Ti^{+4},Fe^{2+} and Fe^{3+} through NH_4OH. The nanoparticles so obtained were incorporated into the polyaniline matrix using in-situ emulsion polymerization. Samples of polyaniline- FT nanocomposite were prepared by taking different weight ratio of aniline to FT for the comparative study. This is followed by the results and discussion including electrochemical studies in order to see the incorporation of FT nanoparticles in the conducting polyaniline matrix. The results of complex permittivity, permeability, and microwave absorption properties of the composite have been discussed.