Name of the Research Scholar: **Abu Darda**
Name of the Supervisor: Prof. Weqar Ahmad Siddiqi
Title of the PHD Thesis: Development of vegetable seed oil based sustainable polymer and their nanocomposites for anticorrosive coatings
Department: Applied Sciences and Humanities

---

**<u>Research Findings</u>**

Various nanoparticles, their hybrids, and oleo-polymer nanocomposites have been formulated successfully via the green route. Characterizing PD oil-based polymers and their nanocomposites produces hydrophobic, cross-linked, well-adhered, anticorrosive, and antimicrobial nanocomposite coatings. PD oil-based polymers are used as matrix, and metal oxides as fillers to form their oleo-polymer nanocomposite coatings.

The Introduction and literature survey part of the thesis discusses the literature on oleo-polymers and oleo-polymer nanocomposites, nanocomposite coatings from sustainable resources, and vegetable oil (VO) as sustainable resources. Oleo-polymer nanocomposite coatings, conducting polymer nanofiller dispersed oleo-polymer nanocomposite coatings, metal, and metal-oxide nanofiller dispersed oleo-polymer nanocomposite coatings, CNT and its hybrid nanofillers dispersed oleo-polymer nanocomposite coatings, corrosion and its prevention on oleo-polymer nanocomposite coatings.

Chapter 2 discusses the formulation and characterization of tungsten oxide enwrapped polythiophene/polyurethane (WO3/PTH-PU) nanocomposite coatings by in-situ polymerization. The structural, morphological, and thermal studies were performed with the help of Fourier transform infrared (FTIR) spectroscopy, X-ray diffraction (XRD), nuclear magnetic resonance (NMR i.e.13C NMR) spectroscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), and them gravimetric analysis (TGA) techniques. The physicochemical properties such as refractive index, viscosity, specific gravity, and physicomechanical properties like gloss (ASTM-D522-93a), scratch hardness (ASTM D1474-98), impact resistance (ASTM D2794-93), bend (ASTM-D522-93a), and cross-hatch test (ASTM D3359B-02) of these coatings were determined by standard ASTM methods. The anti-corrosive performance of these coatings was investigated in 0.5 mol HCl solution for 30 days using potentiodynamic polarization (PDP), electrochemical impedance spectroscopy (EIS), and salt spray test. The antimicrobial activities of these coatings were investigated against (S. aureus, E. coli, and P. aeruginosa) bacteria using the well agar diffusion method. These studies revealed that the formulated nanocomposite coating exhibits excellent corrosion and microbial resistance performance than those of pristine PU coating and other such reported systems. Chapter three discusses the synthesis and characterization of PCz@CNT hybrid nanofiller dispersed polyesteramide nanocomposite coatings. The structural analysis of PDPEtA, PCz-PDPEtA CNT-PDPEtA PCz@CNT-PDPEtA was performed by FT-IR and NMR (1H NMR, 13C NMR). The morphological and thermal studies of these nanocomposites were investigated by optical microscopy, SEM, TEM, and TGA. The physicochemical (refractive index, viscosity, specific density, acid value) and physicomechanical (gloss, scratch hardness, impact, bend, and cross-hatch test) properties of these nanocomposite coatings were also investigated by standard ASTM methods. The corrosion protective performance of these coatings was evaluated using PDP and EIS under a saline (5 wt% NaCl aqueous solution) environment for 20 days using PDP, EIS, and salt spray tests. The PDP was performed for Tafel plots, and EIS data have been used to prepare the Nyquist plots and Bode plots, and phase angle variation to explain the corrosion resistance performance of these coatings. The antimicrobial abilities of these coatings were investigated against (P. aeruginosa, E. coli, B. subtilis, and S. aureus) bacteria using the well agar diffusion method. Moreover, the anti-biofilm activities of these coatings were studied against (S. aureus, and E. coli) bacteria using light microscopic and confocal laser scanning microscopes. These studies revealed that the formulated nanocomposite coating exhibits excellent corrosion and microbial resistance performance than those of pristine oleo-polyesteramide coating and other such reported systems.

Chapter-4 discusses the formulation and characterization of PD seed oil alkyd (PDA), PMF cured PDA (PDA-PMF), and $WO_3$ nanofiller dispersed PDA-PMF ($WO_3$@PDA-PMF) nanocomposite coatings. These nanocomposites were characterized by FT-IR, XRD $^{1}H$ NMR, $^{13}C$ NMR, TEM, SEM, and TGA to investigate their structural, morphological, and thermal properties. These nanocomposite coatings were also investigated for their physicochemical and physicomechanical properties using standard

ASTM methods. The electrochemical corrosion protective performance of these coatings on carbon steel strips (CS) and morphology after exposure to a salt spray chamber were evaluated in 5 wt. % NaCl solutions for 10 days using PDP, EIS, and salt spray test. These studies revealed that the formulated nanocomposite coating exhibits excellent corrosion resistance performance than those of pristine oleo-alkyd coating and other such reported systems.

The last chapter gives a comparative performance of various coating systems reported in this thesis and the influence of the hybrid nanofillers on the corrosion protection performance of the formulated nanocomposite coating systems.