Project Title: Production of sustainable and eco-friendly bio-composite materials derived from polymers and date palm waste for industrial applications in Oman

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Research Field(s): Bio-composites, Manufacturing, Statistical Modeling

Summary and Problem Statement:

The generation of new materials/commodities employing the "from waste-to-wealth" strategy is one of the most demanding and environmently friendly approach due to its economic and environmental benefits. Natural Fiber Reinforced Composites (NFRCs) have attracted significant interest around the globe due to its potential applications in different industrial sectors such as automotive, construction, consumers, etc. This project aims to develop a new class of polymer-based composite materials reinforced with natural fillers (fibers and particles) extracted from date palm trees abundant in Oman. The extracted natural fillers from palm trees are biodegradable, environmentally friendly, and typically considered as waste. Hence, this work will explore the potential use of several parts of the Omani palm tree (leaf, trunk, midrib, and seed) as a source of natural reinforcement additives for plastic polymers. In fact, the success of bio-composite manufacturing depends on natural filler/plastic polymer compatibility, filler distribution homogeneity, and filler/polymer bonding. All aforementioned parameters can be optimized and obtained by proper implementation of novel chemical processing techniques on fillers, hosting polymer, and produced bio-composites. To achieve this, extracted fillers will be chemically modified and functionalized to ensure compatibility with the hosting matrix (polymer). In parallel, an optimization study of the chemical functionalization of commodity plastic polymers will also be considered. In the second phase, novel bio-composite materials will be developed by embedding the functionalized additives, which include metal oxides, Carbon Nao-tubes (CNT) within their composite, into the functionalized matrix at optimized input conditions of fabrication of sustainable modified bio-composites. The hydrophobic nature of the targeted nano-additives will contribute to enhancing the adhesion bonding between the polymer and fibers. Produced bio-composite specimens with different combinations of fiber and polymer types and ratios will be tested experimentally and characterized for mechanical, physical, and thermal properties. Pilot products will be manufactured from the developed bio-composite material and tested under real-life operational conditions. Potential applications of successful bio-composites in the local industry will include door and window manufacturing, deck flooring, fencing, furniture, defense equipment such as helmets, and road barriers. Finally, a feasibility study for Date Palm Plastic Composites (DPPCs) production will be conducted based on the research findings while satisfying the industrial requirements of Oman.

Keywords: Plastics; Polymer; Date Palm Agro-Residues; Eco-friendly; Bio-composite; Municipal Solid Waste; Natural Fibers; Chemical Functionalization; Mechanical Characterization; Manufacturing.

Objectives:

The overall objective of this research project is to explore the potential use of several parts of the Omani date palm tree as natural reinforcement in biodegradable polymer composites. Potential applications of newly developed optimal composites using natural/waste reinforcement in the local industry will be investigated.

Tentative Methods of Approach:

1-Bio-composite fabrication performance evaluation, and process optimization
II- Manufacturing and testing of possible real-life products and conducting a feasibility study

Required backgrounds and skills

Backgrounds:

Experimental testing, Statistical Analysis

Computing Skills:

Other requirements:

References:

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