EDITORIAL

Smart biodegradable composites for automotive applications

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INTRODUCTION

Composite materials having multiple phases offer unique advantages by virtue of the synergistic relationship of its constituents. This has allowed conception, design and manufacturing of materials with unique properties for applications requiring high strength/modulus at low weights, thermal transport, electrical conductivity and corrosion resistance etc. A recent trend in engineering of integrating biodegradable materials in product design has posed novel challenges for the designers and manufacturers of composites. This has been spurred partly by government regulations in the industrialized economies such as End of Life Vehicle (ELV) legislation within the European Union where recyclability of components in automobiles has been a prime focus. The dwindling petroleum reserves and a growing awareness about the global greenhouse gases (GHG) emission has also contributed towards this development.

Composites provide ability to the designers and engineers to incorporate different materials to achieve unique set of synergistic properties otherwise absent in either of its constituent phases. This is evident in the case of composites made from natural fibers and thermoplastic matrix materials. Natural fibers are not only biodegradable but the process of their growth releases $O2$ in the environment as a byproduct of photosynthesis. The thermoplastic matrices on the other hand though not biodegradable per se, are recyclable. Moreover, the $CO2$ released in the environment during the manufacturing and processing of these matrix materials is balanced by the $CO2$ absorbed from the environment by the natural fiber plants. This combination of natural fibers with thermoplastic matrices thus offers a unique combination for the fabrication of environmentally friendly, recyclable composites, the properties hitherto absent in the traditionally manufactured thermoset matrix based composites made from glass, carbon or aramid fibers.

Natural fibers can be further classified into the fruit fibers (Coir, African Palm), seed fibers (Cotton, Capok), leaf fibers (Sisal, Curaua, Fique, Phormium, Palm, Caroa, Corowa, Pineapple) and bast fibers (Flax, Hemp, Kenaf, Abaca, Banana, Bamboo, Jute, Totora) based on the part of the plant which bears these fibers. Among these, bast fibers are generally the longest in length and the strongest in terms of their mechanical strength. It has been found that the specific strength of hemp and flax fibers is comparable to that of glass fibers; primary component in many composite applications such as construction, household appliances and automobiles. Though promising in this respect for automotive applications because of their comparable strength and biodegradable nature, a difficulty encountered with these fibers is that they are hygroscopic and may absorb moisture in outdoor applications. Therefore, they are recommended to be used in the interior automotive parts such as door trim panels, roof stiffeners, dashboard, backrest, rear panel shelf, and roof stiffeners etc.

Intelligent materials are those which can detect changes in their environment and/or their physical state and can respond to that. This is achieved by incorporating sensors inside these structural materials during their manufacturing. Composites offer a unique advantage of using materials for manufacturing which not only endow structural strength and stiffness according to the design criteria but are also capable of inducing sensing properties in them. This can be achieved by designing multi-scale composites with embedded conductive nano-fillers which allow strain sensing in real time. Additionally, these composites should be made intelligent and self-sensing by the incorporation of sensors during composite manufacturing by using techniques which are compatible with their manufacturing process thus avoiding an extra fabrication step and making the sensors integral part of the composites capable of better detecting sub-surface hidden damage and onset of cracks in the fibers and/or fiber-matrix interface.

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