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Enhancing Performance and Sustainability in Engineering Plastics by Using Natural Fillers

There is a rapidly growing demand for more renewable (or sustainable) materials for use in consumer products such as automobiles or children's toys and in building construction materials. It is possible to use natural fillers such as powder made from coconut shells as fillers in plastics such as polypropylene (PP) or polyethylene (PE) to reduce the consumption of oil, which is the feed stock for the production of PP and PE and is not a renewable resource. These fillers can reduce cost and improve performance as well as provide greener products.

Ideally the natural fillers used could be derived from agricultural waste such as coconut shells, rice husks, shells of palm oil nuts, peanut, and walnut, and other agricultural waste products that are poorly utilized at present. Initial work over the past two years using fine powder produced from grinding coconut shells has demonstrated that the stiffness of polypropylene plastic can be doubled by making a composite material of 70% PP and 30% coconut shell powder. However, there are many other agricultural wastes that should be explored, and this will require a more efficient means must be developed to evaluate the suitability of each type of waste for use in composite materials.

The work proposed herein will use a nano-indenter (at Texas A&M University) to determine the hardness of various natural fillers. A scanning electron microscope with a tensile stage (at Baylor University) will be used to characterize the particle size and shape and the strain to failure adjacent fill particles. These experimentally determined values will be used within a computer model that will predict the enhancement or degradation in stiffness and tensile strength (and other mechanical properties) that each filler would be expected to produce. The modeling can be validated by comparing predicted properties for coconut shell filled polypropylene, for which mechanical properties have already been determined. A subsequent proposal to the National Science Foundation will be made using this methodology to very efficiently evaluate the potential of a large number of agricultural wastes for fillers in polymeric composites.