ENVIRONMENTALLY FRIENDLY PACKAGING POLYMERS FROM PETROLEUM, NATURAL GAS, OR BIORENEWABLE FEEDSTOCKS

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Abstract:

Conventional plastics have a wide variety of applications due to their unique properties, including a wide range of thermal properties. However, they are usually made of petrochemical feedstocks, which are nonrenewable, and the resulting products cause environmental problems because of their accumulation and lack of biodegradability. Therefore, the availability of alternative plastics made from renewable staring materials is a critical need, especially for plastics designed for single- and/or short-term uses, such as in packaging applications.

Biomass, a renewable feedstock, is an endless source of small platform chemicals that can be employed in the synthesis of renewable plastic materials. In this document, we focus on utilization of biomass aromatic derivatives having monohydroxy functionality to synthesize thermoplastics. In particular, vanillin, cinnamic acid derivatives (ferulic and *p*-coumaric acids), and 5-hydroxymethylfurfural were selected, due to their availability and structural diversity. After simple acrylation to convert these molecules to polymerizable feedstocks, they undergo radical polymerization to produce acrylate polymers having a wide range of thermal properties capable of meeting the diverse needs of the packaging industry.

Polymerization of vanillin acrylate was investigated under conventional and controlled, reversible addition-fragmentation chain transfer (RAFT), polymerizations. Also, the thermal properties of vanillin acrylate homopolymers were investigated in two ways: (1) by comparing them to those of acrylated syringaldehyde, methyl vanillate, and ethylvanillin homopolymers as a way to study the effect of substituents; and (2) by synthesis of poly(vanillin acrylate) having a range of molecular weights.

Acrylated methyl ferulate and coumarate, as well as their hydrogenated derivatives, were used as model compounds to observe the effect of the rigidity of the polymer pendent group on thermal properties. Compared to the hydrogenated derivative polymer, the

homo- and co-polymers of ferulate monomer showed a significant increase in glass transition temperature with increasing incorporation.

Finally, with increasing the interest in using furan derivatives for polymerization, we are reporting for the first time conventional polymerization and thermal properties of acrylated and methacrylated hydroxymethylfurfural (HMF).