様式 8

論 文 内 容 要 旨

報告番号	甲 先 第 256 号	氏 名	Sunita Basnet
学位論文題目	Synthesis and characterization of biomass derived bio-epoxy resins. (バイオマス由来バイオエポキシ樹脂の合成と機能性評価)		

内容要旨

Increasing industrialization has caused sudden rise in energy consumption. Traditional methods of energy production being based on fossil fuels like oil and gas, have resulted in the emission of excess greenhouse gasses (CO2), which is the main cause for the climactic changes. The climate change (especially temperature rise) could lead the glacier to melt, causing the raise in ocean level subsequently, endangering the existence of plants and animals. Hence, to reduce these kind of environmental issues, an immediate action should be taken to discourage the consumption of fossil fuels, by encouraging the use of renewable plant biomasses. Biomass is one of the most promising alternative energy sources, because of their carbon neutrality and availability from multiple sources.

In the effort to search the different biomass resources for the synthesis of epoxy resins, the renewable resources like green tea extract, lignin extracted from different woody biomasses i.e., eucalyptus, bamboo, and cedar were extensively studied in this thesis work.

The active ingredients of Japanese green tea (Camellia sinensis) were utilized to synthesize bio-based epoxy resin. The catechin compounds in the aqueous extract of green tea were functionalized with epichlorohydrin under alkaline conditions in the presence of tetramethylammonium chloride (TMAC), a water soluble phase transfer catalyst. A good yield of resin was synthesized, and curing was performed with methanol soluble lignin extracted from eucalyptus. The epoxy networks, so synthesized, were compared with bisphenol-A (BPA)-derived epoxy network.

The thermal and mechanical properties of the bio-based resin were assessed through thermogravimetric, flexural strength, and glass transition (Tg) analyses. Catechin-based epoxy networks were found to exhibit good thermal and mechanical properties, rendering them potential BPA substitutes. The thermal decomposition temperature resulting in 5% weight loss (Td5) of synthesized epoxy resin was found to be above 300 ° C, which is slightly lower than that of BPA-derived epoxy resin. The synthesized bio-based resins meet the requirement for the dip-solder resistant temperature (250–280 ° C), with Tg values ranging from 155 to 178 ° C, highlighting their potential use as one of the most suitable BPA substituents as well as their use in electronic materials.

Likewise, a low molecular weight lignin from various lignocellulosic materials was used for the synthesis of bio-based epoxy resins. The lignin extracted with methanol from steam-exploded samples (steaming time of 5 min at steam pressure of 3.5 MPa) from different biomasses (i.e., cedar, eucalyptus, and bamboo) were functionalized by the reaction with epichlorohydrin, catalyzed by a water-soluble phase transfer catalyst tetramethyl ammonium chloride (TMAC), which was subsequently reacted with aqueous NaOH (30 Wt.%) for ring closure using methyl ethyl ketone as a solvent. The glycidylated products of the lignin with good yields were cured to epoxy polymer networks with bio-based curing agents i.e., lignin itself and a commercial curing agent TD2131. Relatively good thermal properties of the bio-based epoxy network were obtained over commercially available bisphenol A (BPA) based epoxy resin. Among the epoxy resins synthesized from three different biomasses, cedar-derived epoxy resin showed the higher thermal decomposition temperature at 5% weight loss (Td5) than those derived from eucalyptus and bamboo, respectively.

However, all the synthesized bio-based resins satisfy the stability requirement temperature, which is between 250-280 ° C, rendering their applicability in the field of electronics (especially in circuit boards). Besides that, the methanol-insoluble residues were enzymatically hydrolyzed to produce glucose, which is one of the major precursors in the field of bio-ethanol fermentation. This study indicated that the biomass-derived methanol-soluble lignin could be e a promising candidate to be used as a substitute for petroleum-based epoxy resin derived from BPA, while insoluble residues could be utilized to obtain a bio-ethanol precursor i.e., glucose.