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Surface Modification and Plating Adhesion Strength of PLA Polymer Using Limonene as a Pre-etching Solvent

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Abstract

PLA (polylactic acid) polymer is a sustainable alternative to petrochemical based polymers for various applications. PLA is biodegradable and recyclable polymer. So, it is considered as an environmentally friendly material. However, when PLA is exposed to sunlight or moisture for a long time, the PLA properties deteriorates, besides it has low thermal stability. Although of these negative characteristics, PLA polymer is the preferred choice for manufacturing different parts. However, plating can overcome these negative characteristics. Pre-treatment (etching) is required on PLA polymer surface to occur electroless plating. It is known to etch the PLA polymer surface using alkaline treatment. It was believed that improved adhesion can be achieved through combining the approach of swelling the polymer surface using organic solvent before etching by alkaline treatment because the organic solvent swells the polymer surface and develops functional groups on the polymer surface, thereby it can adsorb more plating catalyst and plates more efficiently. The aim of this study is to determining organic solvent pre-treatment (using along with alkaline etching treatment) effect on adhesion of plated layer. Limonene was found to be good to use as a pre-etching solvent, as limonene is relatively safe to handle and environmentally friendly. Therefore, combined effect of limonene and alkaline etching treatment was used in this study, besides the modification effect & adhesion strength were investigated. Best results were obtained when using limonene and alkaline etching treatment together.

Keywords: Organic solvent sensitizer, polymer surface oxidation, Limonene, PLA (Polylactic acid)

1. Introduction

Polylactic acid (PLA) is biodegradable and highly useful polymer derived from renewable resources like corn and sugar beets, with a high content of starch, which is converted into polylactic acid during treatment. PLA possesses promising potential in different fabrication processes, i.e., 3-D printing, sheet extrusion, injection moulding, film forming, blow moulding, and thermoforming etc. Low-cost PLA products are used in many applications such as packaging, films, fibres, and in making of moulded articles. The use of PLA polymers in these applications is not only due to its biodegradable properties and being made from renewable resources. PLA is being used because it works very well and provides excellent properties at a low price [1-3]. Yet, when PLA is exposed to sunlight or moisture for a long time, the PLA properties deteriorates, and it has low thermal stability. However, plating can overcome these negative characteristics. Also, the low temperature resistance of PLA polymer has some challenges to the advancement of a technology for its metallisation. The thermal stability of PLA polymer depends on the molecular weight and crystalline phase. It is known that crystalline form of PLA polymer has a melting point around 180°C and amorphous PLA has a glass transition temperature (T_g) of 50–57°C. Important surface pretreatment for the good adhesion of the deposited metal is the process of etching [4-7]. It was believed that including the sensitization treatment before the etching treatment can improve the adhesion

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