Original Research Paper
J. Jpn. Soc. Colour Mater., **88** 〔8〕, 257–264 (2015)

A Novel Metallizing Method on Resin Surface Through Silver Spray Using Triazine Compound

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(Received May 10, 2015; Accepted July 29, 2015)

Abstract

Silver layers were fabricated by a spray electroless deposition approach on acrylonitrile-butadiene-styrene (ABS) substrate functionalized by a triazinedithiol compound of 6-(3-triethoxysilylpropyl)amino-1,3,5-triazine-2,4-dithiol monosodium (TES). TES, which acts as an interfacial molecular layer between ABS and silver layer, contains silylpropyl groups which can react with OH groups on resin surfaces treated by plasma. At the same time, thiol groups can react with silver layer. ABS surfaces treated by different processes were characterized with scanning electron microscopy (SEM), atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), and X-ray diffraction (XRD). The SEM and AFM results showed that continuous, uniform layers of silver were obtained. The effect of plasma treatment time on ABS surface chemical structures was investigated. Additionally, the standard peeling test results showed that the silver layer had the adhesion strength of 23.2 N/mm when plasma treated for 10 min on ABS. From the results of XPS, the reaction of TES on the ABS was confirmed. XRD indicated that the silver layer on ABS surface was not oxidized and mainly existed in the metallic state. This method is fast, simple, nontoxic, palladium and chromium free, which could provide a novel consideration in resin plating industry.

Key-words: *Triazinedithiol, Silver spray electroless deposition, Molecular adhesive, Echingless*

1. Introduction

Silver layers have stimulated a wide range of interest for their superior electrical and thermal conductivity[1)], catalytic[2)], antibacterial[3)], magnetic[4)] and optical properties[5,6)]. Different silver deposition processes such as electroless plating[7)], electroplating[8)], vacuum deposition[9)], and sputtering deposition[10)] have been conducted on various substrates. Electroless metallization is still one of the most effective processes and is applicable to complex-shaped materials or nonconductors, and is also less energy-consuming than other methods. Successful electroless silver deposition on various substrates, such as carbon fibre, silicate glass and cenospheres has been reported in several studies[11-14)]. Yet, uniform and controllable metallic plating on the substrates surface by electroless metallization still needs further improvement. From this point of view, it is demonstrated that the improved spray electroless deposition can be applied to achieve the continuous silver layer on the substrate surface, and realizes the direct deposition of silver onto the substrate. The process is usually carried out by simultaneously spraying the silver salt solution and reduction solution straightly onto the substrate surface in the metallization step. During which the silver layer can be dispersed uniformly and the thickness of the silver layer can be controlled feasibly by changing the spray times[15-17)].

Acrylonitrile-butadiene-styrene (ABS) polymers are among the most widely used polymers in industry as vehicles and electrical devices for their excellent toughness, dimensional stability, chemical resistance, ease of processing, and low cost[18-20)], and was employed as substrate in this study. Considering that the adhesion strength between the metal layer and the ABS substrate is the major concern in practical application, a chromic/sulfuric acid etching is usually applied to increase the surface roughness to obtain favorable adhesion strength[21,22)]. However, the Cr^{6+} is hazardous to environment, and the noble metal Pd that is usually introduced as activation catalyst is costly, which has limited the scope of applications. Also the adhesion quality is still not satisfactory due to the absence of chemical conjunction, and the type and the abundance of chemical functionalities on substrate surface play a major role in the adhesion[23)]. The motivation of our research is based upon the critical need for an environmentally compatible and effective surface modification approach to apply for the adhesion enhancement. Since triazinedithiol compounds have received considerable attention for their functional groups of thermally stable triazine ring and highly reactive thiol groups, which are known to exhibit good chemical conjunction feature with metals such as Cu, Ni, Ag, Au[24-26)], they are expected to