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Metallization and selective metallization of Silver by Spraying.

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Abstract — This paper gives the description of a new direct chemical plating method for silver, called the JET METAL (JMT) process and of the JET SELECTIVE process, which allows to obtain a selective metallization on any substrate which can be metallized with the JET METAL process [1]. This technology is based on spraying separately an aqueous solution containing silver metallic ions together with a CMR free, aqueous based reducing agent. This process allows to plate chemical silver at twelve micron / hour at room temperature and at ambient pressure and is already used in industrial processes for metallizing plastics, composites and non-conductive materials in general and this in different formats (3D pieces, 2D foils, ...). In the second part, some functional applications are being discussed.

I. Introduction

Autocatalytic or electroless metallic plating is widely used to metallize non-conducting surfaces and it is a key technology for manufacturing amongst other printed circuits boards [2]. It is also used for connector applications and to pre-plate a conductive thin film on plastics for subsequent electrochemical plating. One of its most successful applications is Electromagnetic Interference Shielding (EMI / RFI). This “wet” plating technique is a commonly used approach to obtain homogeneous and uniform metal deposits on a catalytic surface and it can be applied to any complex or intricate shape substrate [3]. In spite of all these advantages, electroless plating and electrochemical plating are still suffering from several practical problems such as:

- Bath control and limited solutions shelf life
- Toxicity (i.e.: carcinogen formaldehyde compound are commonly used) and ecological disadvantages (waste treatment, use of chromic etching...)
- Difficulty to plate parts with large dimensions
- Ag plating speed which is limited to 4 - 6 μm / hour for most of commercial available plating solutions

On top of the above mentioned problems, another very important industrial inconvenience should be taken into account which is the high number of processing steps, particularly during the activation step which is at the same moment also a very expensive step. For example, palladium, used to obtain a catalytic surface to initiate copper or nickel depositions, has a price that increased from 100 \$ / oz. in 1997 up to 490 \$ / oz. in 2016. The increasing demand for palladium and the rather limited sources of supply explain the high value of palladium at its price volatility.

A new “direct plating” technology has been developed which avoids the disadvantages listed above and in particular

avoiding the Palladium (Pd) / Tin (Sn) activation step [4,5]. In few seconds after the oxidant and the reducing agent are mixed, it is possible to plate a non - conducting surface (like plastics or composites) with an Ag film without the Pd catalytic activation step. For example, on ABS plastic, a 150 nm Ag metallic under layer (which gives enough electrical conductivity to start an electroplating deposition [4]), is plated in 90 seconds at room temperature and ambient pressure.

The novelty of this plating method is based on a sequentially highly controlled supply of the material (metallic ions Ag^+) and the energy source (CMR and Pd free reducing agent) to the substrate. In other words it can be described as a metal plating process using continuous and simultaneously spraying of two solutions. Using compressed air and a double nozzle paint spraying gun, the reducing and oxidizing agent are sprayed simultaneously onto a substrate surface (can be both a conducting or a non-conducting surface; with or without a complex geometry, big or small dimensions) forming a very thin liquid film as shown in Figure [1]

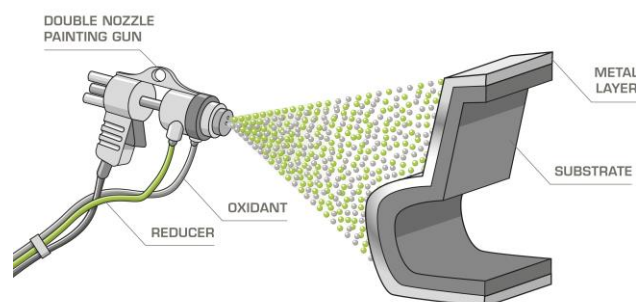


Figure [1]. Principle of the Jet Metal metallization process

The JMT technology overcomes some of the disadvantages of using the Tollens reagents: JMT's sprayed autocatalytic chemical process vs Ag precipitation in a bath with the Tollens reagents, high kinetic JMT silver plating process, JMT's spraying process allows to control the supply of chemical species and thus the silver thickness deposited. Controlling the Ag layer thickness in the JMT process in based on time as the reaction speed is known and this deposited Ag layer thickness can be controlled off-line via measuring the conductivity with a 4 points probe or X-Ray. This film is adsorbed on the surface and contains the active components. The film is thermodynamically unstable which means that the oxidation - reduction reaction will occur

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