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Direct Metallization for Plating on Plastics

A Synopsis[*] of a Presentation given at SUR/FIN 2017 (Atlanta, Georgia)
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Editor's Note: The following is a synopsis of a presentation given at NASF SUR/FIN 2017, in Atlanta, Georgia on June 19, 2017 in Session 3, Technologies for Performance.

ABSTRACT

A new combination of copper immersion and autocatalytic copper-(I)-oxide deposition enables lower palladium concentrations in the activator bath, though the amount of copper deposited on the plastic surface can be up to ten times higher compared to its predecessor processes. This way the drag out cost of palladium is minimized further. Further, the use of this new combination of copper deposition mechanisms enables a reduction of the surface resistivity of the resulting layer by a factor of about ten compared to older direct metallization processes. Besides easier direct plating on large plastic surfaces and PC-ABS blends, one major advantage is the high stability of the new process.

Introduction

A primary goal in the development of plating process for ABS plastics is the simplify the process sequence, reducing the number of steps. In particular, eliminating the electroless nickel and/or copper strike steps thru direct metallization has been important. Over the last two decades, research and development efforts at Atotech have worked toward this end, striving for high performance and reducing costs in direct metallization processes for ABS and ABS/PC. In this article a survey of a new proprietary state-of-the-art direct metallization system NeoLink®E was given by Mr. Joseph Arnold.

The Technology

As shown in Fig. 1, the process involves a drop-in modification in the standard ABS process sequence following the etch, neutralization and catalyst activation steps. Instead of an electroless process, the original standard direct process used an adherent immersion copper coating (Cu-Link®) to replace the tin layer. The new development involves a novel immersion deposit (NeoLink®E) to produce a thick conductive layer of copper (by tin exchange) and promote autocatalytic growth of 200-nm copper oxide crystals on the surface, to allow direct electroplating of the decorative process sequence.

The resulting layer is adherent, and is sufficiently conductive to allow the workpiece to enter directly the acid copper plating step with no further intermediate steps. The process is highly stable, requiring no chemical stabilizers. It is cost efficient, easy-to-use,

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and is suitable for both small and large ABS and ABS/PC plastic parts. A comparison of the bold and new processes is shown in Fig. 2

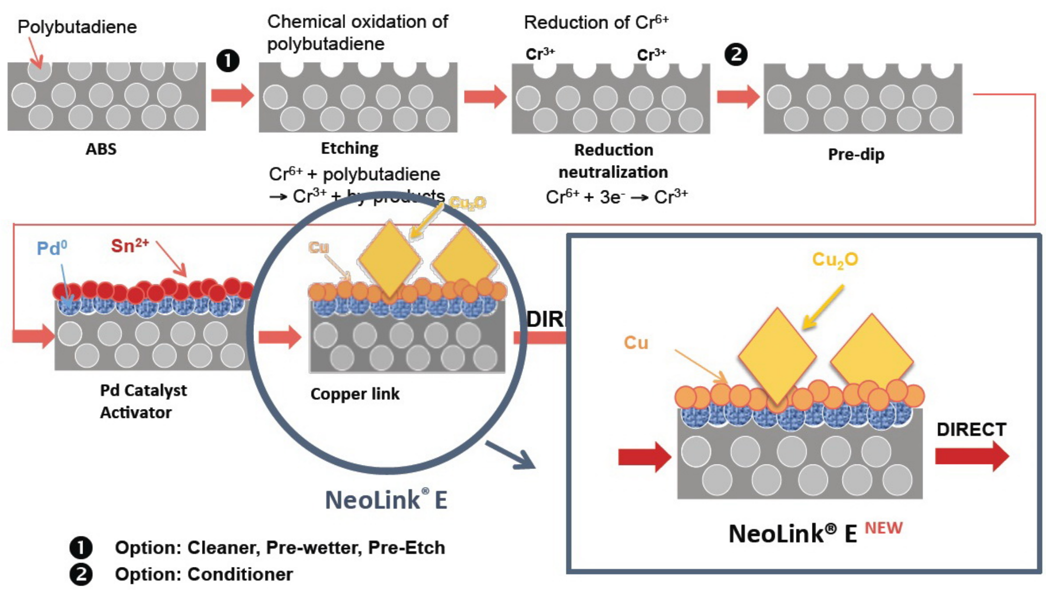

Figure 1 – Direct metallization process sequence.

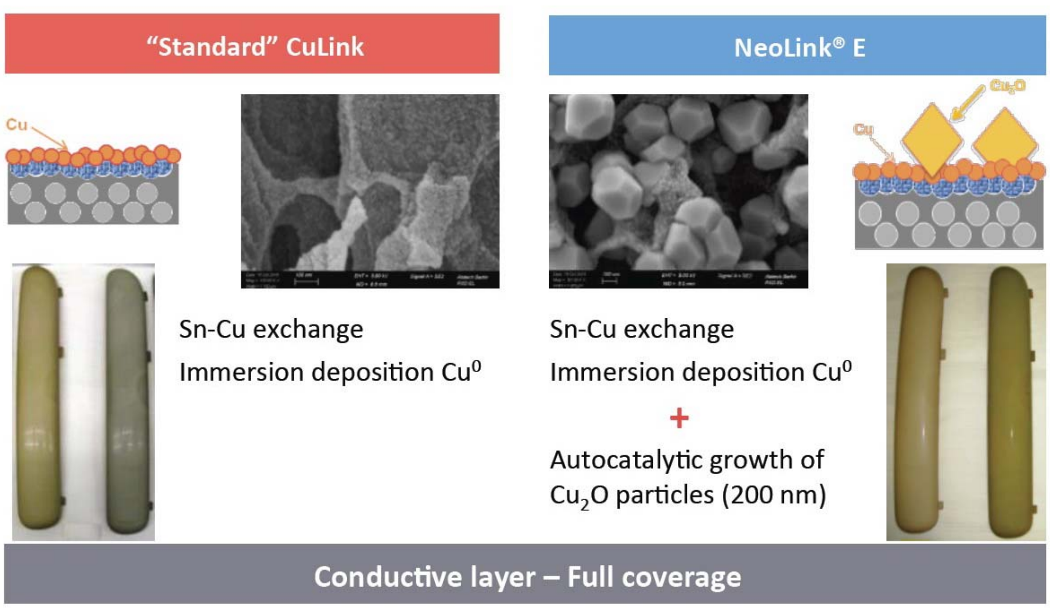

Figure 2 – Principle summary of direct metallization processes.

Test Results

The fact that tin in the activator layer is replaced by copper along with the development of copper oxide crystals makes for increased conductivity, as seen in Fig. 3. Further, the activator can operate with reduced palladium content, reducing palladium dragout and operating at higher efficiency.

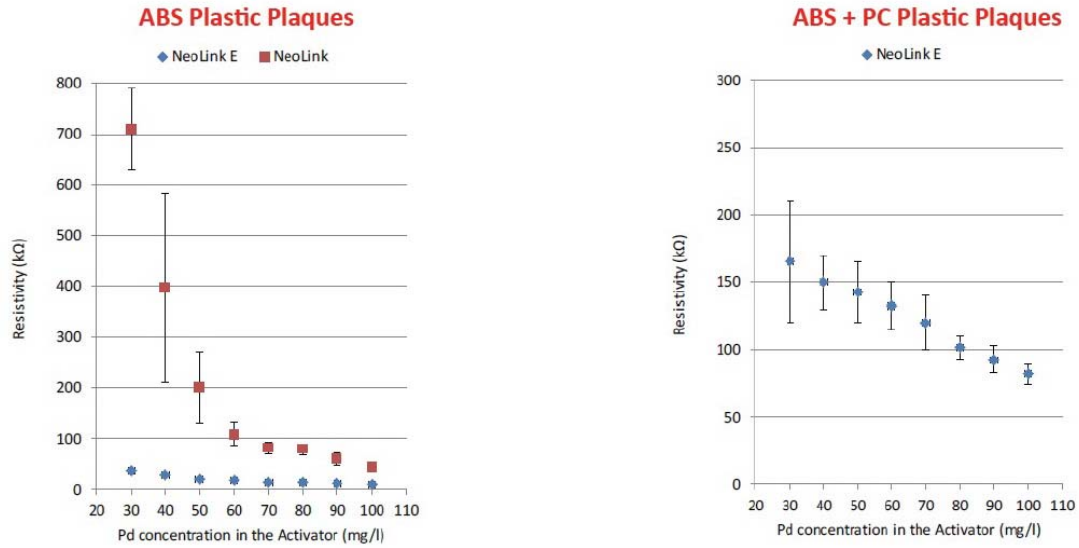

Figure 3 – Low resistivity / high conductivity on ABS and ABS-PC.

Production results

In production testing, it was shown that coverage increased, despite the reduction in palladium concentration (Fig. 4). In the figure, it can be seen that full coverage is achieved with 30 ppm Pd with the immersion copper/copper oxide process. This contrasts with the conventional technology results shown, with 50 ppm Pd required for full coverage.

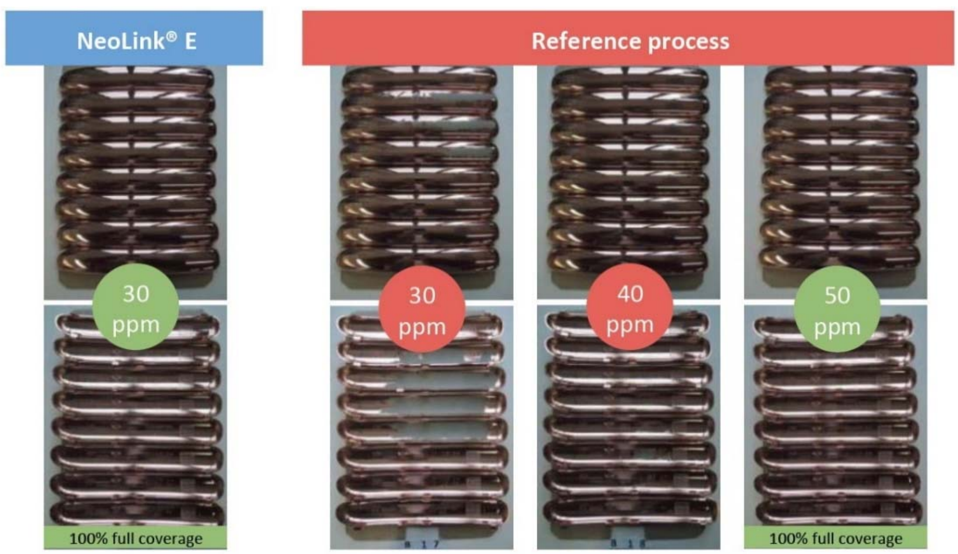

Figure 4 – Coverage performance improved with lower palladium content.

During the process time, there was no discernible increase in particle size of the copper oxide crystals. Rather, there was an increase in particle density, which continued for up to 8 minutes deposition time (Fig. 5). With this was an increase in layer conductivity.

Of course, the primary concern for any plating-on-plastic application is plate adhesion. The OEM specifications for plate adhesion for a selection of manufacturers is shown in Fig. 6, based on a standard acid copper plate thickness of 30-40 µm.

Actual parts processed with the new immersion technology were tested and compared with standard technology as a reference. Values were comparable. An ABS cap showed an adhesion value of 14.2 N/cm (8.1 lb./in.) for the Neolink technology versus 14.8 N/cm (8.5 lb./in.) for the conventional processing, significantly higher than the OEM specs. An ABS-PC BMW Mini front panel processed with the immersion Cu/Cu oxide process showed an adhesion value of 7.3 N/cm (4.2 lb./in.) versus 7.2 N/cm (4.1 lb./in.) for conventional processing.

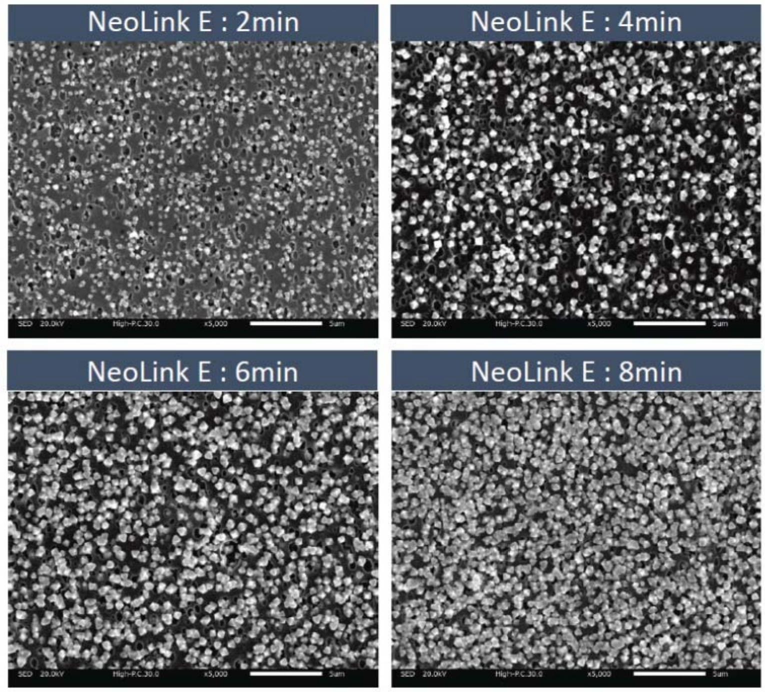

Figure 5 – Effect of immersion time on the layer structure (Activator time - 5 min; immersion Cu/Cu oxide time 2, 4, 6, 8 min)

OEM Specifications for Adhesion	ABS	ABS+PC
General Motors – GMW 14668	9.0 N/cm (5.2 lbs/in)	4.5 N/cm (2.6 lbs/in)
FORD – WSS-M1P83-E2 2016	9.0 N/cm (5.2 lbs/in)	4.5 N/cm (2.6 lbs/in)
Volkswagon – TL 528 2015	7.0 N/cm (4.0 lbs/in)	3.5 N/cm (2.0 lbs/in)
Toyota – TSH6504G 2007*	9.8 N/cm (5.6 lbs/in)	9.8 N/cm (5.6 lbs/in)

*Note: Toyota does not make a distinction between ABS or ABS+PC substrates

Figure 6 – OEM adhesion specifications for plated ABS and ABS-PC plastics (30-40 µm electrodeposited acid copper).

Summary

In summary, Mr. Arnold noted that operating costs for the new Neolink®E technology were similar to those for conventional processing. Significantly thicker copper deposits were obtained on the plastic surface in the form of copper metal and copper oxide. No visible surface roughness was observed with the presence of Cu_2O cuprous oxide particles in the layer. In production, a layer with higher surface conductivity was available prior to acid copper plating, and excellent coverage was achieved. In operation, the palladium concentration required in the activator solution was lower, leading to reduced dragout and lower costs. With no stabilizers needed, the solution was easy to use, and was suitable for both small and large parts molded from ABs and ABS-PC.

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Joseph Arnold is GMF Business Development Manager North America (DECO/POP) at Atotech USA Inc. He graduated with B.S. Degrees in Biology and Chemistry from Western Kentucky University in 1980 and 1982, respectively. He has spent 25 years in chemical related manufacturing, including 18 years in chromium plating on plastics. He has worked for Tier I and II suppliers to the automotive industry as Chief Chemist, Department Manager, Plant Manager, Corporate Technical Director and Consultant. He has helped to start five plating on plastics lines from the ground up – three in the U.S., one in Mexico and one in Spain.