New Improved Direct Metallization Process

NeoLink® E

Joe Arnold – SUR/FIN 2017

Technology for tomorrow's solutions
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Direct Metallization: NeoLink® E

Principle
NeoLink® E – Direct Metallization
New Generation of Copper Link for Direct Metallization

- New design of copper link (CuLink)
- Higher deposit conductivity before Acid Copper Plating
- Improved efficiency and lower contend of Pd in the working Activator Bath
- Highly Stable process – without the use of chemical stabilizers
- Cost efficient process – high productivity
- Easy to use
- Suitable for ABS & ABS+PC
- Suitable for small & large parts
# NeoLink® E – Direct Metallization

## Process Sequence

<table>
<thead>
<tr>
<th>NeoLink® E</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaner (Optional)</td>
<td>UniClean® 151 or Alkalume 141</td>
</tr>
<tr>
<td></td>
<td>Cleaning step to remove fingerprints or other dirt</td>
</tr>
<tr>
<td>CrO$_3$-H$_2$SO$_4$ Etch</td>
<td>NeoLink® Additive CR</td>
</tr>
<tr>
<td></td>
<td>Changing the ABS surface morphology &amp; polarity</td>
</tr>
<tr>
<td>Reducer</td>
<td>NeoLink® Reducer CR</td>
</tr>
<tr>
<td></td>
<td>Reducing left over CrVI on the surface to CrIII</td>
</tr>
<tr>
<td>Pre-dip</td>
<td>Conditioning of liquid film on parts to lower impact on Catalyst</td>
</tr>
<tr>
<td>Coll. Pd - Catalyst</td>
<td>NeoLink® Activator E</td>
</tr>
<tr>
<td></td>
<td>Activating of surface with colloidal Pd particles</td>
</tr>
<tr>
<td>Copper Link</td>
<td>NeoLink® E</td>
</tr>
<tr>
<td></td>
<td>Cross linking Pd particles and creating conductivity</td>
</tr>
</tbody>
</table>

*New!*
Standard Process Sequence for ABS
Direct Metallization – NeoLink® E

1. Polybutadiene
   Chemical oxidation of polybutadiene
   \[ \text{Cr}^{6+} + \text{polybutadiene} \rightarrow \text{Cr}^{3+} + \text{by-products} \]

2. Reduction of Cr
   \[ \text{Cr}^{6+} + 3e^{-} \rightarrow \text{Cr}^{3+} \]

3. Etching
   Reduction neutralization
   \[ \text{Cr}^{6+} + 3e^{-} \rightarrow \text{Cr}^{3+} \]

4. Pre-dip

5. Pd Catalyst Activator
   Sn²⁺
   Copper link

Option: Cleaner, Pre-wetter, Pre-Etch
Option: Conditioner

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Direct Metallization

Mechanism

“Standard” CuLink

Chromosulfuric acid etch → PdSn → CuLink

NeoLink® CuLink

- Immersion deposition Cu\(^0\)
- Very fine grain structure

NeoLink® E

- Immersion deposition Cu\(^0\)
- Autocatalytic growth of Cu\(_2\)O particles (200 nm)

Conductive layer – Full coverage
Direct Metallization

SEM Pictures
Direct Metallization

Principle Summary

“Standard” CuLink

Sn-Cu exchange
Immersion deposition Cu$^0$

NeoLink® E

Sn-Cu exchange
Immersion deposition Cu$^0$ + Autocatalytic growth of Cu$_2$O particles (200 nm)

Conductive layer – Full coverage
Direct Metallization: NeoLink® E

Test Results

High Conductivity / High Copper Adsorption
Results on ABS
High Copper Adsorption with NeoLink® E

• Comparison of *Pd, Sn and Cu-adsorption* values on ABS Novodur P2MC – activator: 3 min (40ºC) @ 40 ppm Pd on:
  - Reference CuLink
  - NeoLink® CuLink
  - NeoLink® E

*Note: adsorption is given as information only and cannot be used as reference/quantitative indication*
Effect of NeoLink® E
Resistivity, Tin & Copper Adsorption
Palladium Activator @ 5 minutes 44°C
CuLink @ 5 minutes 60°C

- Comparison of *Pd-, Sn-, Cu- adsorption* and *resistance* on ABS+PC parts (BAYER T45):

<table>
<thead>
<tr>
<th>Activator parameter</th>
<th>NeoLink® E Activator – 5 min @ 44°C, different ppm Pd Mini Front Finishers (MFF)</th>
<th>Pd [mg/m²]</th>
<th>Sn [mg/m²]</th>
<th>Cu [mg/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 ppm Pd</td>
<td>after activator</td>
<td>36-42</td>
<td>33-38</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>after Reference CuLink</td>
<td>36</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>after Neolink E</td>
<td>38</td>
<td>8</td>
<td>285</td>
</tr>
<tr>
<td>50 ppm Pd</td>
<td>after activator</td>
<td>45-49</td>
<td>44-50</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>after Reference CuLink</td>
<td>42</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>after Neolink E</td>
<td>50</td>
<td>10</td>
<td>375</td>
</tr>
</tbody>
</table>

*Note: adsorption/resistivity are given as information only and cannot be used as reference/quantitative indication*
Results on ABS
High Conductivity

- Comparison of *resistivity* of layers deposited on ABS after NeoLink® E and NeoLink® - Activator 3 min (40ºC) @ 40 ppm Pd:

*Note: resistivity is given as information only and cannot be used as reference/quantitative indication*
## NeoLink® E – Direct Metallization

**Process Sequence for ABS & ABS+PC**

<table>
<thead>
<tr>
<th>NeoLink® E &amp; Standard CuLink</th>
<th>Process Sequence, Time &amp; Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CrO$_3$-$H_2$SO$_4$ Etch</strong></td>
<td>68°C – 10 minutes NeoLink® Additive CR</td>
</tr>
<tr>
<td><strong>Reducer</strong></td>
<td>30°C – 1 minute NeoLink® Reducer CR</td>
</tr>
<tr>
<td><strong>Pre-dip</strong></td>
<td>25°C – 1 minute HCl</td>
</tr>
<tr>
<td><strong>Coll. Pd - Catalyst</strong></td>
<td>40°C – 5 minutes NeoLink® Activator E</td>
</tr>
<tr>
<td><strong>Copper Link</strong></td>
<td>60°C – 5 minutes NeoLink® E</td>
</tr>
</tbody>
</table>
Comparison of *resistance* on ABS & ABS/PC after NeoLink® E

*Note: Resistivity is given as information only and cannot be used as reference/quantitative indication*
Direct Metallization: NeoLink® E

Results

Increased Coverage at Lower Pd Amounts
Results on ABS
Activator: 5 min (44°C) @ 30 ppm Pd

NeoLink® E

100% Full coverage FS/BS*
No flow lines

Reference process

Coverage: 100% FS* / 95% BS*
Light flow lines

*FS = Front Side, BS = Back Side
Results on ABS/PC
Activator: 5 min (44ºC) @ 30 ppm Pd

- NeoLink® E: 100% Full coverage FS/BS
- Reference process: Coverage: 50-60% FS / 20-50% BS
Results on ABS/PC
Activator: 5 min (44°C) @ different ppm Pd

NeoLink® E

Reference process

30 ppm

100% full coverage

30 ppm

100% full coverage

40 ppm

50 ppm

100% full coverage
Effect of NeoLink® E – Immersion Time
Resistivity & Copper Adsorption – Palladium Activator @ 5 minutes 44°C

- Resistivity is decreased with an increased immersion time in NeoLink® E
- Copper Adsorption is increased with an increased immersion time in NeoLink® E
Effect of NeoLink® E – Immersion Time

SEM 5,000 X Magnification

- ABS Plastic Substrate
- NeoLink® Activator: 5 min
- NeoLink® E: 2, 4, 6, 8 min
- No relative increase in particle size, Cu$_2$O, after 4 minutes only an increase in particle density
Direct Metallization: NeoLink® E

Results

Standard Adhesion
Adhesion

Standard Sequence with 30 – 40 Microns of Acid Copper Deposition

<table>
<thead>
<tr>
<th>Actual Parts (Not Plaques)</th>
<th>NeoLink® E</th>
<th>Reference Process</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS Cap</td>
<td>14.2 N/cm (8.1 lb/in)</td>
<td>14.8 N/cm (8.5 lb/in)</td>
<td></td>
</tr>
<tr>
<td>ABS/PC BMW Mini Front-Finisher</td>
<td>7.3 N/cm (4.2 lb/in)</td>
<td>7.2 N/cm (4.1 lb/in)</td>
<td></td>
</tr>
</tbody>
</table>

Comparable Adhesion
to the reference process & conventional EN

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

*Note: Toyota does not make a distinction between ABS or ABS+PC substrates
Direct Metallization: NeoLink® E

Main Features

- Similar costs to “Conventional EN Process”
- Significantly higher copper deposition on the plastic surface as copper metal and oxide
- No visible surface roughness due to Cu$_2$O cuprous oxide particles
- Higher conductivity/lower resistance of the surface prior to acid copper plating
- Excellent coverage in the acid copper
- Required Pd concentration in the activator is reduced compared to previous generations
- High stability without stabilizing chemicals
- Only 3 replenishment solutions required
- Easy to use
- Suitable for ABS and ABS/PC, also for large parts
Direct Metallization: NeoLink® E

In a nutshell

- Cost savings in Palladium Reduction
- High Conductivity “Large Parts” Capable
- Fewer Additives
- Larger Working Window
- Much Better Coverage on ABS+PC
- Ease of Operation
Thank you
for your attention!

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