Corrosion Study of Amine-Quinone Polyimide Using Electrochemical Impedance Spectroscopy

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INTRODUCTION

• Previous corrosion study of our group showed Amine-Quinone (AQ) Polyurethanes, which inhibit the corrosion of iron particles, proved better than those commercial binders used in MP tapes. However, their thermal stability is poor.
• Polyimides (PI) are widely used in advanced materials technology because of their excellent thermal stability, good mechanical and attractive electrical properties. However, polyimides are susceptible to corrosive media and uptake of water.
• Nikles and Han have developed a new AQ polymer, AQ Polyimide (AQPI-2), which has the good thermal stability. If AQPI-2 has good corrosion protection property, the new area of polyimide chemistry will be opened.
AQPI-2 vs PI

**AQPI-2**

Tensile Strength 140 Mpa
Tensile Modulus 1.1 GPa

**PI**

Td 554°C  Tg 282 °C
Tensile Strength 169 Mpa
Tensile Modulus 1.5 GPa
Bode Plots and Equivalent Circuits for PI (12 µm) on Iron
Bode Plots and Equivalent Circuits for AQPI-2 (12 µm) on Iron
Coating Resistance and Capacitance of PI vs Exposure Time

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Coating Resistance and Capacitance of AQPI-2 vs Exposure Time

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Water Uptake of Polymer Film

\[ X_v \text{ (volume\%) = } \left[ \log \left( \frac{C_t}{C_0} \right) / \log(80) \right] \times 100 \]

<table>
<thead>
<tr>
<th>Polymer Film</th>
<th>Exposure Time</th>
<th>( X_v )</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQPI-2 (12 ( \mu m ))</td>
<td>360 Days</td>
<td>8%</td>
</tr>
<tr>
<td>AQPU100 (9 ( \mu m ))</td>
<td>90 Days</td>
<td>3%</td>
</tr>
<tr>
<td>PEN (11 ( \mu m ))</td>
<td>2 Hours</td>
<td>16%</td>
</tr>
<tr>
<td>PEN (25 ( \mu m ))</td>
<td>2 Hours</td>
<td>13%</td>
</tr>
<tr>
<td>PET (13 ( \mu m ))</td>
<td>2 Hours</td>
<td>16%</td>
</tr>
<tr>
<td>PET (16 ( \mu m ))</td>
<td>2 Hours</td>
<td>15%</td>
</tr>
<tr>
<td>ARA (5 ( \mu m ))</td>
<td>2 Hours</td>
<td>31%</td>
</tr>
</tbody>
</table>

Water Uptake Plot of AQPI-2 and Comparison with Commercial Films
CONCLUSIONS

• The new class of high-temperature polymer coating AQPI-2 offers better corrosion protection for iron and copper as compared to PI. It raises the possibility of the MP tape binders used in extreme environments.

• Water uptake calculation demonstrated that AQPI-2 absorbed very small amounts of water (< 8% vol/vol) after 360 days of exposure on iron and copper. The resistance of AQ polymers to moisture absorption is one important reason for their good corrosion protection for iron and copper.