

A New Generation of Corrosion Resistant Evaporator Boats

Abstract:

Over the last few decades, evaporator boats have been playing a key role in the metalizing and coating industry. Aluminium and other metals, such as silver, gold and copper are examples of materials used to provide homogeneous and stable coatings on paper, plastics and other substrates.

For this application, the evaporator boats are fixed between two electrically conductive clamps and resistance heated, under vacuum, to the operating temperature of around 1500 °C. The heat-up time from room temperature to the process temperature is usually a matter of a couple of minutes and therefore requires high temperature stability of the boats. Moreover, they need to withstand great temperature shocks as the heat-up and cooling-off time are relatively short and repeated multiple times during the boats life, depending on the cycle time. During the metallization process, a metal wire melts on the boat's surface (touching point) and flows in both directions towards the boat's ends. The flow rate is the highest near the touching point, leading to a high erosion and formation of cavities at both sides of the wire touching point. Also, the liquid metal, such as aluminum, will react with the boat's surface, which leads to the material and quality degradation. Thus, as a consequence of the corrosive and erosive attack, the boats life time is directly affected.

Therefore, a new generation of evaporator boats has been developed to improve both, the corrosion resistance and the performance during the metalizing process. For this purpose, two major points have been taken into account: the binder phase and the powder matrix formulation. Several investigations have shown in the past that the liquid aluminum reacts with the binder phase and softens the particle adhesion. As a result, the particles providing for both the electrical conductivity and the resistivity are flushed away by the flowing liquid metal, primarily next the touching point. That explains the above-mentioned cavity formation. In fact, scanning electron microscopic (SEM) and X-Ray diffraction measurements (XRD) showed the presence of recrystallized particles at the boats ends that have been removed from the material surface near the wire touching point. Furthermore, cross sectional microscopic observation revealed the formation of a layer resulting from an interaction between the liquid aluminum and the boats surface.

The addition of other compounds, such as oxides, nitrides and carbides should help improve the material stability at operating conditions. The oxides would react with the used binder phase to build a high melting point product, providing a much better stability, even at temperature above the operation conditions. By adding the carbides and nitrides, not only would the binder phase be strengthened, but also the particle stability against aluminium attack is expected to be improved.

Different batches of modified evaporator boats were produced, selected in-house and tested, along with standard boats for the sake of comparison. Both boats grades were tested at exactly same conditions and had the same geometry.

A clear difference could be observed as both, the standard and modified boats were compared after the metallization process. The standard boats had wider and deeper (about 30% deeper) cavities than the modified ones. Indicating the modified boats exhibited a higher corrosion resistance. Thus, the life time of the modified boats is expected to be improved by at least 20%.

These first results show that the binder phase and particle modification have an effect on the corrosion resistance. Further tests will need to confirm the correlation between corrosion resistance and life time.