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Growth of nanostructured oxide coating by Plasma Electrolytic Oxidation (PEO)

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In the early history of Plasma Electrolytic Oxidation (PEO), the process was conducted in positive (anodic) DC mode. It is however well established now that the use of AC or bipolar DC current is beneficial to the PEO coating growth, although no discharges are usually observed during the cathodic polarisation. Moreover, Jaspard-Mécuson et al. [1] showed that in a particular regime (soft regime) in which the positive to negative charge quantity ratio (Qp/Qn) is less than one, the quality of coating is significantly improved while drastic changes in the plasma behaviour are observed. The transition from arc to soft regime usually lasts a few minutes during which the impedance of the coating strongly changes, likely because of modifications in the coating microstructure.
Recent investigations on coatings obtained with soft regime conditions have shown that what is usually considered as dense alumina in the so-called pancake-like structure is actually a nanocomposite, made of a stacking of 80 – 100 nm thick Al-rich and 30 - 40 nm Si-rich sublayers when the process is run in a silicate-containing electrolyte. Interestingly, the stacking is found to be regular over several microns. This presence of this structure might explain the increase in compactness and hardness observed in coatings synthesized in soft regime conditions.
Combining these observations with the nanometre-size porosity network [2], we will discuss about the possible coating growth mechanisms as the process progressively switches from arc to soft regime.

[1] F. Jaspard-Mécuson, et al. Surf. Coat. Technol. 201 (2007) 8677□8682
[2] J. Curran, T.W. Clyne, Acta Mat., 54 (2006)1985□1993

Keywords
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