Multifunctional nanostructured coatings on light alloys produced by plasma electrolytic oxidation

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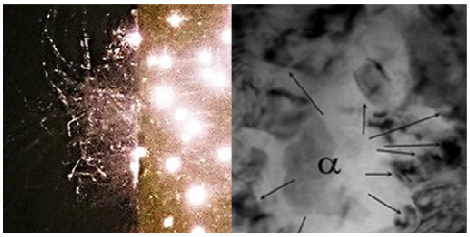

Fig. Typical appearance of electrolytic plasma discharge (left) [1] and α-Al_2O_3 nanograins formed on Al surface at near-room bulk temperature (right) [2].

Nanostructured surface layers produced by Plasma Electrolytic Oxidation (PEO) of lightweight metallic materials, such as Al, Ti, Mg and Zr alloys, attract increasing interest in many practical fields. Formation of the surface nanostructures in this advanced anodizing process is influenced by plasma microdischarges that appear at the interface between the metal electrode and an aqueous electrolyte at sufficiently high voltages (Figure). The microdischarges that typically last less than a millisecond provide local instantaneous excursions for small volumes of material to high temperatures and pressures, causing thermal-chemical and metallurgical transformations in the surface layer at the near to ambient bulk substrate temperatures. As a result, sintered ceramic layers containing both stable and metastable compounds with a diverse range of morphologies can be produced. This allows properties of parent metals to be modified, providing enhanced mechanical strength, chemical stability or additional functionality. This presentation will discuss nanostructured features formed due to plasma-assisted chemical conversion of metallic substrates or electrolytic synthesis and deposition of chemical compounds. Incorporation of nanoparticles in the surface layer from slurry electrolytes will also be considered. Particular attention will be given to understanding how to control the PEO process to produce coatings with desirable characteristics. Selected examples will be provided to illustrate key enabling features (e.g. performance enhancement, energy saving, multi-functionality and environmental impact) that can be achieved using PEO technology and associated nanostructured surfaces in transportation, electronics, catalysis and biomedical applications.

References:
[1] EV Parfenov, et al, SCT 203 (2009) 2896
[2] RHU Khan, et al, ibid 205 (2010) 1679.