PULSED ELECTRON BEAM SURFACE MODIFICATION OF HYPEREUTECTIC AL-SI ALLOYS AS PRETREATMENT TO IMPROVE HARD ANODIC OXIDE COATING PROPERTIES

V. MATALONI[1], M. BESTETTI[1,2], A. LUCCHINI HUSPEK[1], YU.H. AKHMADEEV[3], E.A. PETRIKOVA[3], YU.F. IVANOV[3], P.V. MOSKVIN[3], AND N.N. KOVAL[2]

[1] Politecnico di Milano, Department of Chemistry, Materials and Chemical Engineering "Giulio Natta", Milano, Italia.
[2] Tomsk Polytechnic University, Department of Experimental Physics, The Weinberg Research Centre, Tomsk, Russia.
[3] Institute of High Current Electronics Siberian Branch of Russian Academy of Science, Tomsk, Russia.

Aluminum alloys play a crucial role in several engineering fields, like aviation, aerospace, automotive, construction, electronics and marine industry. Their wide use is related to their excellent combination of properties, including low density, high strength-to-weight ratio, excellent electric and thermal conductivity, good castability and machinability, and easy recycling. The addiction of alloying elements allows to enhance mechanical and thermal properties. In aluminum-silicon alloys, the content of Si usually varies between 4 and 25 wt.% and other alloying elements, such as Cu, Mg, Mn, and Fe, may be added in smaller amounts. The formation of a surface oxide layer is exploited to provide high corrosion resistance, hardness and wear resistance. However, the anodizability of Al-Si alloys is strongly influenced by the presence of alloying elements, that make the achievement of a consistent and durable anodic layer a challenging task.

In the present work, the hypereutectic AlSi13 and AlSi34 alloys are considered. Figure 1 shows the micrographs of the as received alloys. The presence of large primary Si particles together with the Si particles in the eutectic structure causes the formation of a highly defective anodic oxide in which non-oxidized Si particles and gas-filled porosities are frequently encountered. Pulsed electron beam sources, namely RITM-SP and SOLO, are employed to achieve the redistribution of Si in the surface and subsurface layers of the alloys, producing a more homogenous surface region with smaller and finely dispersed particles. In particular, the influence of different energy densities (3-5 J/cm^2 for RITM-SP and 25-40 J/cm^2 for SOLO) and different number of pulses was investigated. The hard anodic oxidation is carried out in 2M H_2SO_4 aqueous solution at 0°C with a current density of 3 A/dm^2 for 15, 30 and 45 min.

Surface and cross-sectional morphology was investigated using a Zeiss EVO 50VP SEM equipped with a Bruker Quantax X-ray spectrometer for EDS chemical microanalysis. The crystalline structure was characterized by X-ray diffraction in Bragg-Brentano by means of a PANalytical EMPYREAN PW1830 diffractometer. Microhardness and elastic modulus were assessed by instrumented microindentation using a Fischer H100 Vickers microindenter. Electrochemical behaviour of coatings was characterized by a Solartron Modulab XM ECS potentiostat in 3.5% NaCl solution at room temperature.

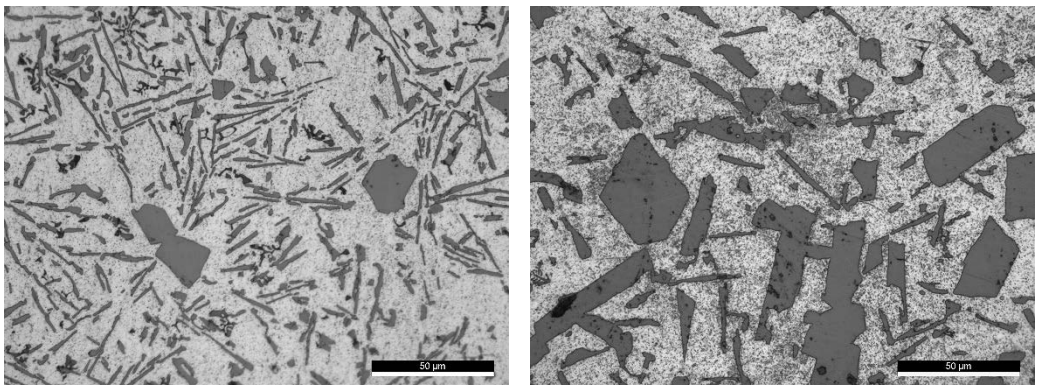

Fig.1. Optical microscopy images of pristine AlSi13 (left) and AlSi34 (right) alloys.