La Metallurgia
International

S d y of micropar icle incorpora ion in coa ing on i ani m prod ced b y pla ma elec ro y ic o ida ion (PEO)

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This research is focused on the analysis of the influence of rutile (TiO_2) and anatase (TiO_2) microparticles (d < 5 m) on the morphology, structure, and anticorrosive properties of PEO coatings on titanium produced in alkaline based solution containing sodium hydroxide and sodium metasilicates or nanoclay particles (hydrophilic bentonite, $H_2Al_2O_6Si$, d < 25 m).

PEO coatings are characterized by scanning electron microscope (SEM), energy dispersive spectroscopy (EDS) and X-ray diffraction (XRD). In addition, the samples are electrochemically investigated by electrochemical impedance spectroscopy analysis.

The tests carried out have shown that the incorporation of TiO_2 microparticles in the coating leads to the formation of thick oxide layers characterized by a fine porosity. These coatings provide good corrosion protection when samples are ty3.vi0 Td[(m78 Td(are ty3.vi0Tc 0 Tw 5.247 0 0d1umnf,cs.)Tjegs .2d8 Td(are ty3.d, thosei3.cparticles in the coasasasasasas

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a) b)

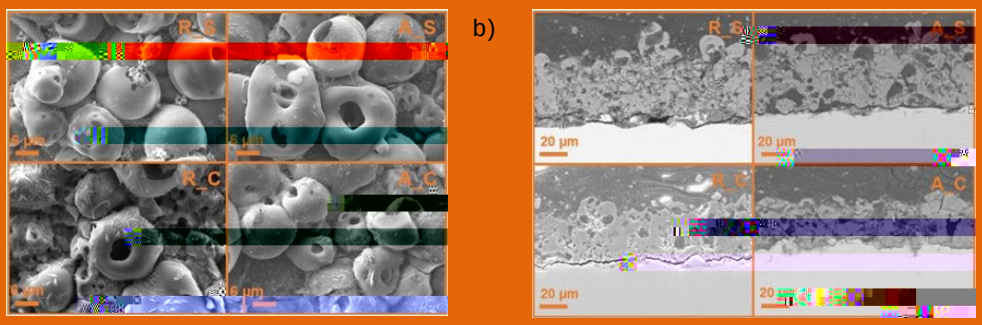
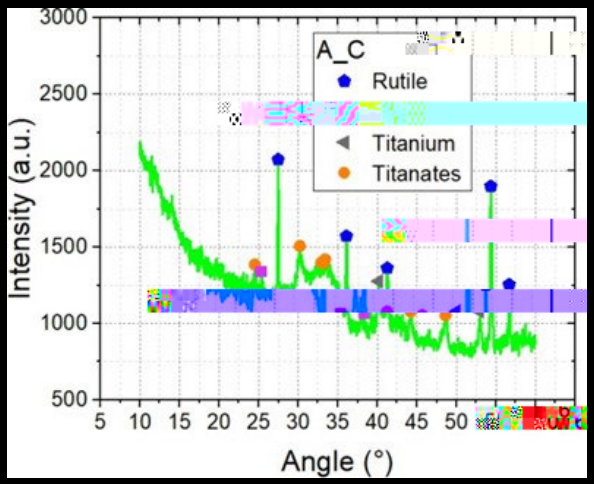


Fig. 1 - a) SEM images of the surfaces of PEO samples; b) SEM images of the cross-sections of PEO samples.

The analysis of the sections of the coatings using SEM (Fig. 1 b) allows to estimate the thickness of the oxides. By working with rutile particles, coatings with thicknesses of approximately 52 m (R_S) and 35 m (R_C) are reached, in the presence of silicates and nanoclay respectively. As regards the samples treated with anatase, thicknesses of approximately 49 m (A_S) using silicates and 30 m (A_C) in the presence of nanoclay are obtained.

It could be noted that the greater thicknesses are achieved b ng with metasilicates in addition to the micropartic result of a double effect, i.e. t reduces th its growth, Another im the oxides, in electroly porosity, t microparticles are characterized by larger pores. These large defects may compromise the corrosion protection effect as they allow the penetration of the aggressive solution through the oxide. Coatings produced in the presence of rutile particles are instead characterized by the presence of cracks at the interface between the substrate and the oxide itself; this defect could potentially compromise the adhesion of the coating to the substrate. The EDS analyses (not reported) allow to verify the presence of Ti, O, Na and Si in all the samples. Furthermore in the coati



The XRD a shown in F presence o

Comparing the results of the impedance tests obtained for the PEO specimens with those of the untreated Ti grade 2 (Fig. 4. a), it is observed that the behavior of the samples changes significantly. The Nyquist diagram of bare Ti presents a double semicircle typical of a corrosive process and a polarization resistance, R_p (defined as the intersection of the arcs that interpolate the Nyquist graphs with the axis of the real impedance Z') typical of an active electrode (about 70 Ω cm^2). [11] The specimens coated with PEO oxides, instead, show only one capacitive semicircle and R_p values that are four and five orders of magnitude higher for the samples treated with nanoclays and metasilicates, respectively, compared to Ti grade 2. These values demonstrate the corrosion protection ability of PEO coatings.

Looking in more detail at the graphs relating to PEO coatings (Fig. 3) it is immediately possible to notice an important difference between the oxides produced using the two different types of Si-containing additives.

First of all, [illegible] pedance curves of the samples treated with nanoc[illegible] with reduced diameter, an indication [illegible] R_C and A_[illegible] values are [illegible] same cond[illegible] section, bu[illegible] approxima[illegible] prepared w[illegible] with larger [illegible] are observe[illegible] indicated fo[illegible] sample Ti_[illegible] be partly ju[illegible] the two ty[illegible] R_S and A_[illegible] greater tha[illegible] nanoclay; t[illegible] by making [illegible] consequen[illegible] by studyin[illegible] values it ca[illegible] diameters [illegible] decrease. [illegible] and A_S inc[illegible] solution. T[illegible]

of corrosion products that fill the pores of the coating, improving its corrosion protection effect.

Finally, it is noted that the impedance values achieved by A_S and A_C are slightly higher than those obtained by their respective rutile-containing counterparts. This phenomenon is probably due to the lower crystallinity of the samples produced through the incorporation of anatase particles, which therefore provide greater resistance to the passage of electrons generating higher impedances. However, it has been widely demonstrated that rutile guarantees better behavior against acid corrosion in long-term tests. [12]

By observing the trend of the imaginary impedance, it is possible to evaluate the kinetics of the ongoing relaxation phenomena. The diagrams obtained (not shown) present a single time constant at low frequencies therefore attributable to a corrosion reaction controlled by the diffusion of aggressive species through the coating. [13]

CONCLUSIONS

This paper describes [illegible]

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