Nanostructured surfaces

Crystal structure of oxide ceramic coatings formed on VT5 and VT14 titanium alloys

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The aim of this work is to determine the phase composition and porosity of oxide ceramic coatings synthesized on VT5 and VT14 titanium alloys for the formation of coatings with specified functional properties.

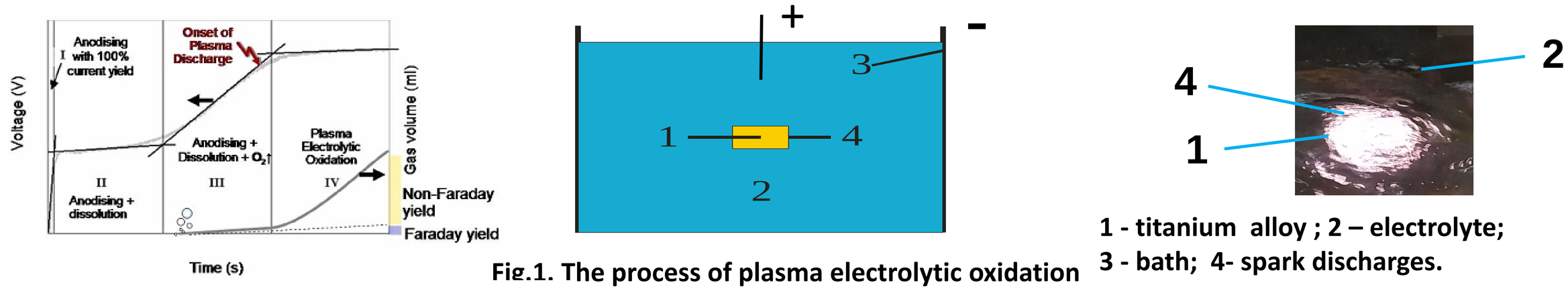
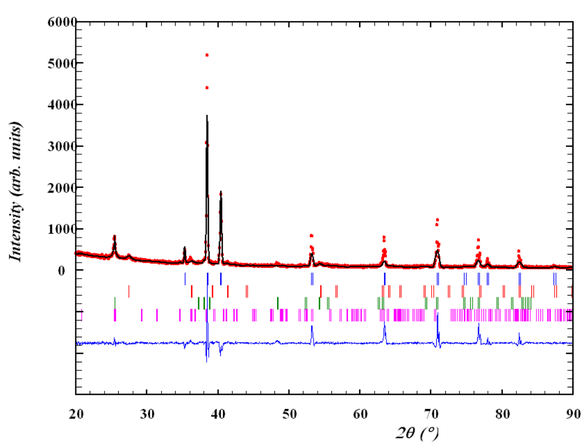
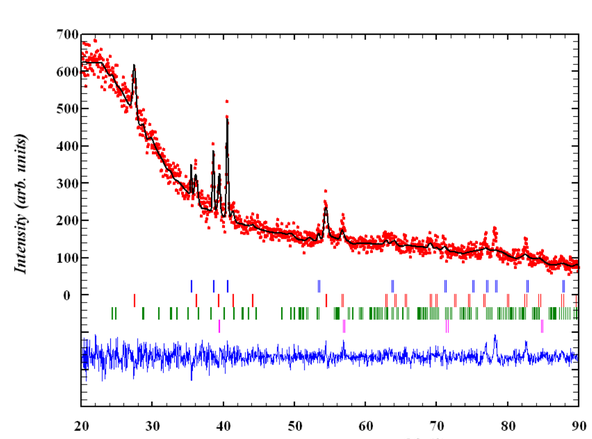


Fig.1. The process of plasma electrolytic oxidation



a

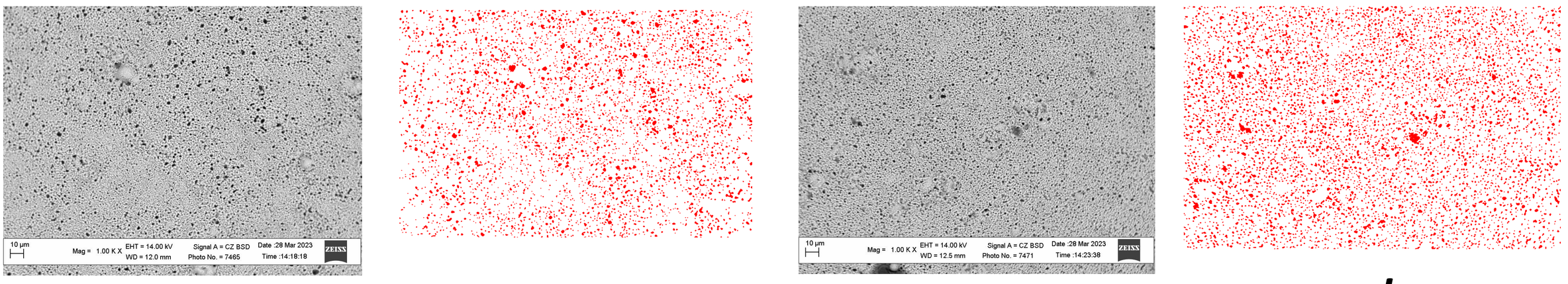
Phase	a	b	c	SG	%
α-Ti	2.9329(3)	2.9329(3)	4.6805(5)	P63/mmc	63.91
TiO_2 (rutile)	4.5981(7)	4.5981(7)	2.9447(3)	P 42/mmn	16.84
TiO_2 (anatase)	3.7624(4)	3.7624(4)	9.4613(5)	I 41/amd	2.00
TiO_2 (brookite)	6.1067(3)	8.5550(6)	4.8917(6)	P c a b	17.25



b

Phase	a	b	c	SG	%
α-Ti	2.9205(8)	2.9205(8)	4.6665(1)	P63/mmc	13.61
TiO_2 (rutile)	4.5904(3)	4.5904(3)	2.9559(5)	P 42/mmn	19.95
TiO_2 (brookite)	6.2436(3)	7.1798(8)	5.7893(1)	P c a b	62.60
α′-Ti	3.2344(8)	3.2344(8)	3.2344(8)	Im3m	3.84

Fig. 2. X-ray diffraction of oxide ceramic coatings after 5 min (*a*) and 30 min (b) synthesis on VT14 alloy.



a ***b*** ***c*** ***d***

Fig. 3 Surfaces of oxide ceramic coatings on VT5 (a, b) and VT14 (c, d) alloys after 5 min PEO synthesis and their segmentation results (b, d).

Conclusions

An X-ray phase analysis of oxide ceramic coatings formed on VT5 and VT14 alloys in the process of plasma electrolytic oxidation in the electrolyte (KOH (3 g/l), Na_2SiO_3 (2 g/l)) was carried out. It was established that already at the beginning of the coating synthesis (after 5 min) in the surface layers of both alloys, titanium oxides are synthesized. The elemental composition of the obtained coatings was analyzed by electron X-ray microscopy. It was established that the element distribution in oxide ceramic coatings is almost the same. Oxide ceramic coatings on both alloys consist of oxygen, titanium, silicon, and aluminum. The phase composition of coatings was investigated by X-ray structural analysis. Quantitative phase content was calculated by the Rietveld method. It was established that the diffractogram of the oxide ceramic coating synthesized on the VT14 alloy consists of TiO_2 (brookite), TiO_2 (rutile), TiO_2 (anatase) and a-Ti reflections, and on the VT5 alloy only of a-Ti reflections. This indicates a major difference in the alloys coating thickness.

After 30 min of synthesis, the corresponding oxide ceramic coatings on VT5 and VT14 alloys contain the following phases: TiO2 (brookite), TiO2 (rutile), a significant amount of α-Ti and traces of α′-Ti. The thickness of the oxide ceramic coating on VT5 alloys is 80-100 µm, and on VT14 is 90-150 µm.

Segmentation of the obtained images has been carried out and the distribution of pores by size has been calculated. The dependence of pore sizes in the coatings on the alloying of the original alloys was established. The minimum pore sizes for VT5 is $6.93 \cdot 10^{-14}$ m^2 and for VT14 – is $2.77 \cdot 10^{-13}$ m^2.