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Research of the morphology and microhardness of titanium plasma-sprayed coatings after thermal modification at different pressures of the working medium

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The formation of titanium coatings by plasma spraying (PS) is widely used in the manufacture of medical products. The disadvantages of this method are low adhesive strength and cracking of the coating. To improve the mechanical characteristics of the formed coatings, it is proposed to use induction thermal treatment (IHT), as well as to form nanosized structural elements on the titanium surface.

It is known that the composition and pressure of the gas mixture during IHT affect the composition and properties of diffusion layers. For example, vacuum annealing makes it possible to more than double the impact strength of titanium. It is also worth noting that with an increase in the annealing temperature, the microhardness of the material increases. It is known that brittle oxide layers are formed after this treatment, but an increase in temperature leads to a decrease in the thickness of the brittle layers. Therefore, the purpose of the work was to qualitatively determine the influence of the pressure of the working (reaction medium) on the morphology and microhardness of titanium plasma-sprayed coatings.

Methodology

The coating was formed by the PS of PTS grade titanium powder using the UPN-28 installation under the following modes: plasma torch arc current - 350 ± 5 A; spraying distance - 150–170 mm. The subsequent induction-thermal modification of the samples was carried out on the VCh-15 facility. The disks were heated to 900–950 ˚C for 120 and 300 s in air (Fig. 1a) and at reduced pressure (60 ± 5 Pa) in a special chamber (Fig. 1b).

Results

The study of the morphology by the SEM method showed that there is a significant change in the structure at the nano level in comparison with the heat treatment of the coatings in air. IHT in air promotes the formation of oxide prismatic, elongated crystals of the order of 2–5 μm (Fig. 1c). After treatment at reduced pressure, spherical particles 100–200 nm in size began to predominate in the structure (Fig. 1d).

Measurement of the microhardness of microsections of samples with coatings modified by IHT in air at a processing time of 120 s showed that the maximum microhardness was 1553±249 $HV_{0.98}$, which is associated with the formation of a hardened diffusion layer. With a holding time of 300 s - 1599±178 $HV_{0.98}$.

Measurement of the microhardness of microsections of samples with IHT in vacuum at a holding time of 120 s contributed to a decrease in microhardness to 892±78 $HV_{0.98}$ at the coating surface. With a holding time of 300 s, the hardness increased to 1002±292 $HV_{0.98}$ and remained at the same level over the entire cross section.

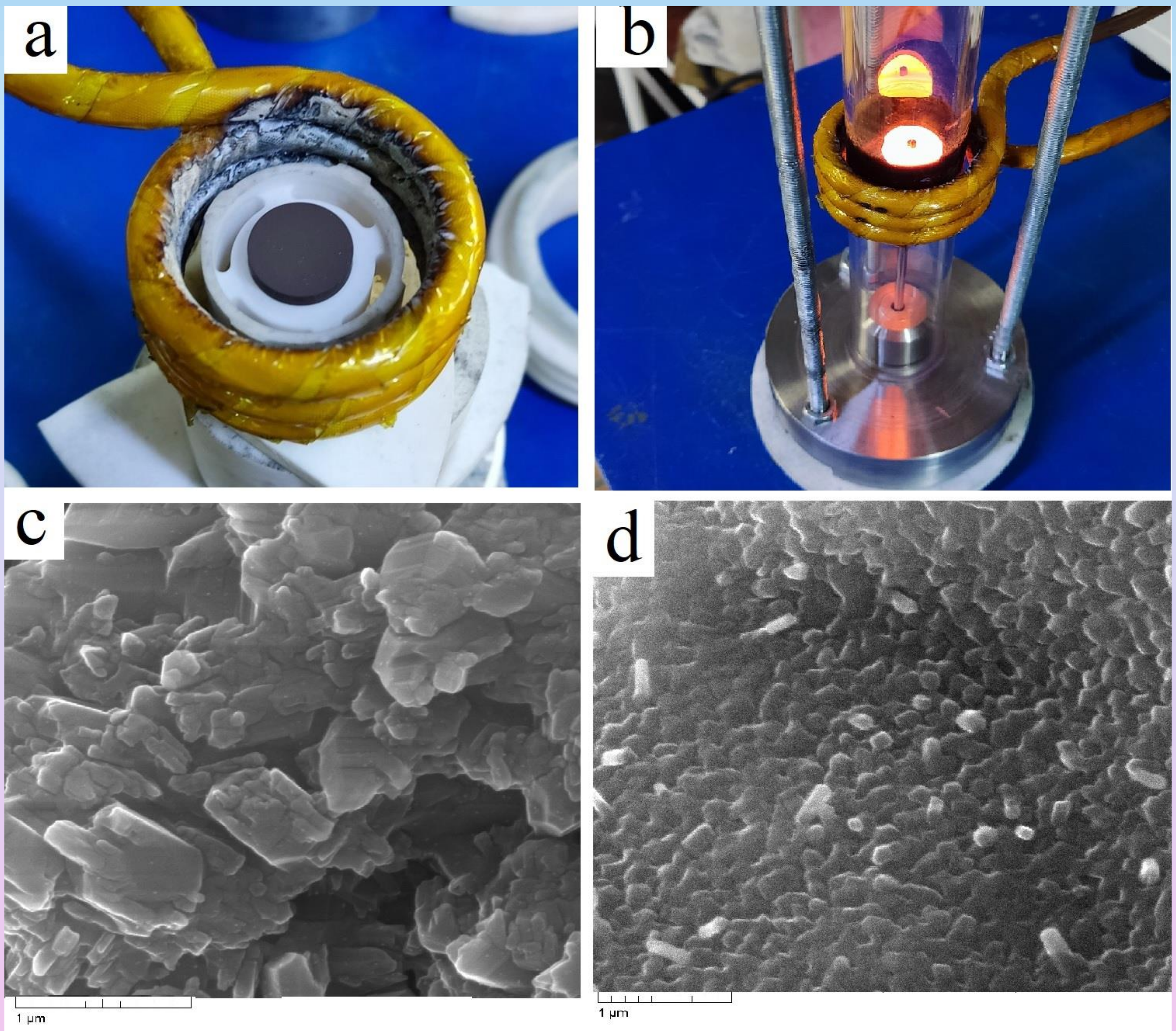

Fig. 1. IHT in air and in technical vacuum: a - IHT at atmospheric pressure; b – IHT in vacuum; c - the morphology of IHT in air; d – morphology of IHT in vacuum

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