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THE EFFECT OF PRELIMINARY MECHANICAL ACTIVATION OF TITANIUM POWDER IN ARGON ON SUBSEQUENT ACTIVATION IN NITROGEN.

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Nitrides of refractory metals are of great interest for study due to their properties. They are widely used in engineering as various kinds of additives and coatings, as well as independent materials. Fine grinding of green materials is widely used for the synthesis of ceramic materials, while the rate of solid-phase reactions increases due to the "pumping" of excess elastic energy into the material and an increase in the surface area of the reagents. An important characteristic in these processes is the state of the grain surface of the components, which can change markedly due to the course of mechanochemical reactions involving the surrounding gas environment. The grinding of substances is used in production and is an important technological process. Most often, various kinds of mills are used as grinders, in which grinding is carried out with the help of grinding bodies located in the chamber together with the crushed powder.

In this paper, the regularities of the mechanical synthesis of titanium nitride during mechanical activation of titanium powder in a nitrogen atmosphere are investigated. Experimental studies of the mechanochemical synthesis of titanium nitride have revealed that mechanical activation intensifies chemical transformation in the Ti - N system, and the intermittent mode allows synthesizing the final product under "soft" controlled conditions without noticeable heat release [1].

In this paper, studies on the preliminary mechanical activation of titanium powder in argon were carried out in order to increase the defectiveness of the powder in advance. It was assumed that the pretreated powder would absorb nitrogen better.

Two series of experiments were carried out: in one, the mechanical activation time of titanium in argon changed (10 s, 30 s, 3 min, 5 min) with a constant time of 5 min mechanical activation of titanium in nitrogen. In the second series, the mechanical activation time of titanium in argon was unchanged for 10 min and the mechanical activation time of titanium in nitrogen (17, 25, 40 min) changed.

Titanium powder (TU 14-22-57-92) was ground and mechanically activated in an M-3 planetary mill in nitrogen (high grade, GOST 9293-74). The initial size of titanium particles did not exceed 100 μm.

The morphology and size of the powders were studied by scanning electron microscope (Philips SEM 515 with EDAX attachment and electronic focused ion beam system Quanta 200 3D). The phase composition of the final products was characterized by X-ray diffraction analysis DRON-UM1 (CuKα radiation).

The dependence of nitrogen assimilation by titanium, with the preliminary mechanically activated of titanium in argon, was investigated. Analysis of the data obtained from photo, X-ray and microanalysis showed that at short exposure times, preliminary mechanical activation in argon accelerates nitrogen absorption, and at large, it slows down.

This deceleration can be explained as follows: when activated for some time (activation time in argon plus activation time in nitrogen), all particles go into a nanostructured state and stop grinding, fresh surfaces disappear, nitrogen does not decompose and nitriding stops. Thus, the preliminary mechanical activation of titanium powder in argon reduces the time of effective activation in nitrogen, at which fresh surfaces are formed.

REFERENCES

[1] Oleg Lapshin, Olga Shkoda, Oksana Ivanova and Sergey Zelepugin, Discrete One-Stage Mechanochemical Synthesis of Titanium-Nitride in a High-Energy Mill, Metals 2021, 11, 1743. https://doi.org/10.3390/met11111743