THE INVESTIGATION OF THE CRYSTALLOGEOMETRICAL PARAMETERS OF NANO-POWDERS OF REFRACTORY ALLOYS

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Introduction

Nano-powders of the pure metals and their alloys are used as modifying agents for the treatment of ferrum-carbon melt. [1,2]. For efficient modifying the nano-powders ought to correspond to the definite crystallogeometrical requirements which consider the modified material properties, thermodynamic conditions also ought to be kept [3,4].

General consideration

The analyses of thermodynamic and kinetic processes in ferrous melt created the necessary prerequisites for the conclusion that nano-particles with the size less than 100 nm are commensurable with the sizes of crystallization centers during the solidification of the product; coagulation of the particles at melt poling depends on the specific surface energy at the boundary metal-particle; particles' dissolve resistance depends on the absorbing film sizes on their surfaces and the phase surface energy amounts. With the particle size decreasing to 100 nm and less, the particles' dissolve resistance increases. In order to prevent aggregation of the particles in a melt and to improve their wettability, it is necessary to isolate the particles from each other by means of clabbing.

Obtained by means of plasma chemical synthesis nano-powder compositions of pure titanium, titanium carbide, titanium nitrite, and titanium carbonitride with the size of 10 … 100 nm are investigated.

The synthesis of nano-powders is held at the unit with vortex induction plasmatron and gaseous stabilization of the charge. As the raw materials the wastes of titanium-magnesium and silicon-polymer industries are used. The target product was formed via the injection of initial powders in the nitrogen plasma flow at the temperatures ranging from 5500^0C to 7000^0C [3]. The main quantities of the particles had the sizes no more than 100 nm. The obtained nano-powders are good getters, which have chemical absorbing and adhesion properties, but they are inclined to aggregation in vacuum and have oxidizing ability. It limits their applying as modifying agents.

Crystallographic and dimensionally geometric form were defined by means of microdiffraction method at ДРОН-2,0 (DRON-2.0) unit at CuK_α radiation. Microscopic images and micro-diffraction picture analysis of the nano-powders showed that artificially obtained via plasma chemical synthesis nano-powder compositions sustained the self- faceting abilities, they are of three-dimensional model. Plasma gas bulk condensation that permits particles' free crystal-lizing surface favours to it. TiC particles are formed in the cuboid and tetragon shapes, their crystals configuration projection at crystal orientations or other axes parallel to the cathode beam. The reflexes have round shape without tension bars in the microcrystallogram that proves the absence of dislocation deviations of the unit, that means perfect lattice.

Electromicroscopic analysis of nano-powders shows that they have cuboid lattice with the parameters: a_{TiC}=0.4349 nm; a_{TiN}=0.4243 nm; a_{TiCN}=0.4256 nm; these match the bulk recrystallized powders data (a_{TiC}=0.4319 nm).

The investigation of diffraction line intensity and recrystallized powders showed a drastic area reduction under an integrated intensity line for annealed powders, it could be connected with microscopic displacements. Comparation between-plane distance on difraction pictures titan carbonitride present in the table.

Table

r_{1} ., mm	D_{HKL}., Σ	D_{TIC}, Σ	HKL_{TIC}	λα,Σ
8,50	2,45	2,49	111	20,80
9,65	2,16	2,15	200	20,80
13,65	1,53	1,92	220	20,80
16,00	1,31	1,30	311	20,80

In the error measures 1% the waves between-plane distance d_{HKL} make up 0,01…0,2 Σ. As follows, the carbon-nitride titan-louv forms on base titan-carbide with parameter $d_{111(TiC)}$ = 2,49 Σ. Nitride-atoms exists in position carbon atoms and generates the solid solution type replacing in titan-carbide.

The method on the clabbing for nano-powders by means of applying the microlayer on them that consists of wax of methane series [4] is developed and introduced. The oxygen percentage in clab powders is 8.0 … 8.5 times lower than in the powders that does not undergo clabbing. Clabbing preserves particles from oxidizing, also it favours to the rising of kinetic and aggregative stability.

The thickness of the oxide film on the particles' surface may reach 10 nm (15-20% of particles' size) at the oxygen content of 6 to 8 mol %. At the primary stage of absorbing layer formation the oxygen is on the surface of the particles as H_2O molecules. The annealing of nano-powders induces oxygen stripping: absorbed forms O^- and OH^- are found on the particles' surface. After long storage ion Ti^{+3} can be found on the surface of the powders based on TiCN [5].

Conclusion

Nano-powders with the size of 10 … 100 nm are obtained by means of plasma chemical synthesis. It has been discovered that for the efficient modifying the nano-powders based on titanium ought to correspond crystallogeometrically to the ferrous melt. The type of the lattices and the parameters of Ti-, TiC-,TiN-, TiCN-nano-powders are defined by means of X-ray-structural analysis.

References

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