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STRUCTURAL DIAGRAM OF VANADIUM-CERIUM SYSTEM

By

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Structural Diagram of Vanadium-Cerium System

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Ye.M.Savitskiy; V.V.Baron; Yu.V.Yefimov

The structural diagram of the Vanadium-Cerium system has not been formulated to this day. Literature data[1] about the reaction of vanadium with cerium are limited to information, that this system is similar to other V - p.z.e. systems.

Employing methods of macro-and microstructural, thermal and x-ray analyses, as well as the microhardness method was investigated the structural diagram of the vanadium-cerium system up to 50 weight percentages of cerium. As basic materials served: carbothermal vanadium (99.766%) and metallic cerium (98.8%). The fusions were prepared in an arc furnace with nonconsumable tungsten electrode on a copper water-cooled bottom in an atmosphere of purified titanium getterated helium under a pressure of 0.9 atm. To attain uniformity in composition along the ingot, the alloys were subjected to fourfold resmelting. The annealing of alloys, containing up to 1 weight percentage of cerium, was done at 1100° for a period of 100 hrs, and alloys with greater cerium content - at 750° for a period of 200-250 hrs in quartz evacuated ampoules.

During macro-and microstructural analysis (fig.1a) of the alloys was revealed the appearance of a second layer, rich in cerium, beginning with 0.2 - 0.3% of Ce. The vanadium rich layers, were monophase (fig.1b). Solubility of cerium in solid vanadium is very low and remains almost unchanged at a change in temperature. Maximum solubility of cerium in vanadium equals 0.1%.

Fig.1.Microstructure of vanadium-cerium alloys: a-separation boundary of two layers of vanadium alloy with 50% Ce; b-vanadium layer of very same alloy.

Data about maximum solubility of Ce have been confirmed by the microhardness method. When measuring microhardness on the PMT-3 instrument at a load of 100 g it was found that microhardness of pure vanadium upon the addition of 0.05 - 0.1% of Ce rises from 150 to 165 - 170 kg/mm^2. Upon a further increase in the Ce content in the batch the microhardness of vanadium changes little.

Fig.2.Structural Diagram of vanadium-cerium system

No intermediate phases are formed in the system. On the powder roentgenogram of the vanadium alloy with 50% Ce (VK_α - radiation) were visible only vanadium lines and cerium lines. The parameter of the vanadium lattice (a = 3.029 Å) does not change during fusion with cerium.

By measuring the melting point by the drop method, which is described in report [2] it was established, that the temperature of a monotectic equilibrium is very close to the melting point of vanadium (1885±15°). By a differential thermal microanalysis, described in report [3] it was established that vanadium raises the melting point of Ce very little (by 5-7°), forming with it, apparently, a peritectic, and reduces by 20-25° the temperature of polymorphous transformation of gamma-Ce into δ - Ce.

Smelting of technical vanadium, contaminated with oxygen and nitrogen, with cerium leads to a reduction in its hardness and rise in plasticity in cold state, as it has been observed also in other rare metals [4]. Molten Ce affects each vanadium bath as a deoxidizing flux as result of formation of CeO_2 and CeN. Cerium reduces the content of oxygen and nitrogen in vanadium to a level, at which these admixtures produce no negative effect on its plasticity.

Vanadium, refined with cerium, is cold rolled without intermediate annealings to a high degree of deformation (95%).

By the results of these investigations was plotted a structural diagram of the vanadium-cerium system, as shown in fig.2.

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