Superconductivity in Zirconium–Rhodium Alloys

The phenomenon of superconductivity in zirconium-rhodium alloys at cryogenic temperatures has been studied at Argonne National Laboratory.

In the work, metallographic studies and transition temperature measurements were made with zirconium-rhodium alloys that had been isothermally annealed and water-quenched. The results clarify both the solid-state phase relations at the Zr-rich end of the Zr–Rh alloy system and the influence upon the superconducting transition temperature, $T_c$, of structure and composition. The data clearly demonstrated that superconductivity in the Zr–Rh system is sensitively dependent upon both composition and structure. For martensitic $\alpha$, $\omega$, and $\beta$ phases, $T_c$ increases with increasing Rh concentration. Rhodium is only slightly soluble in $\alpha$-Zr, if at all, and thus has little or no effect on the transition temperature of the $\alpha$ phase. An intermediate phase, Zr$_2$Rh, has a $T_c$ equal to 10.8°K, while another phase, ZrRh, is normal down to 1.7°K.

Alloys were prepared from zirconium crystal bar and 99.9+% pure Rh by arc-melting on a water-cooled hearth in an inert gas atmosphere. The alloys were then given a homogenization heat treatment for 72 hours at 1000°C and water-quenched. Specimens were then cut from the homogenized castings and isothermally annealed at temperatures between 600° and 1200°C for 72 to 168 hours. For all heat treatments, the specimens were wrapped in zirconium foil and sealed in an inert gas atmosphere inside quartz capsules. After all heat treatments, the alloys were quenched by breaking the capsules under water. The phases present in the quenched alloys were identified by optical and X-ray metallography. Diffraction patterns were obtained with a 114.6 mm-diameter Debye–Scherrer camera using either CuK-$\alpha$ or CrK-$\alpha$ radiation. The lattice parameters of the Zr$_2$Rh and $\omega$ phases were determined by a least-squares computer program. Superconducting transition temperatures were determined from magnetic permeability measurement in a 10 oersted field.

Notes:
2. This study may be of widespread interest, since superconductivity has application in ore beneficitation; chemical, physical, medical, and biological research; and electronic devices.
3. Inquiries concerning this innovation may be directed to:
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Patent status:
Inquiries about obtaining rights for commercial use of this innovation may be made to:
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