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AEC-NASA TECH BRIEF

Levitation-Melting Technique for Metals and Alloys

Experimentation at Argonne National Laboratory has led to improved techniques for levitation melting of special metals, alloys, and intermetallic compounds, along with designs for two levitation coils and a technique for helium quenching. The greatest hindrance to the use of levitation melting has been the lack of available information on levitation coil designs.

Levitation melting is a recent technique for melting metallic materials by suspension of the dense charge in space with an electromagnetic field. The main advantage of this method for preparing alloys is that a completely homogeneous melt can be produced quickly. Other attractive features of this technique are: (1) The molten charge can be solidified while levitated to minimize contamination by direct contact with other materials. (2) Alloys with a specific shape can be achieved directly by dropping the molten charge into a preshaped mold. (3) The specimen can be rapidly cooled, minimizing the amount of segregation upon solidification.

This investigation had the following objectives: (1) to develop levitation coils capable of melting a wide variety of metals and alloys, especially the transition-metal alloys; (2) to cast alloys into specific shapes directly from the molten state, particularly brittle intermetallic compounds not amenable to conventional shaping techniques; and (3) to develop a gas-quenching technique so that high-purity alloys in the liquid state could be quenched to the solid state without contamination.

Two coil configurations were developed that permit a wide variety of metals to be levitated successfully in the molten state. Although only limited quantities of material may be processed with the present coils, the quantities are adequate for research purposes. While the two coils resemble previous designs, the overall dimensions were increased to allow for larger charges. Also, the size of the copper tubing was increased to provide a greater cooling capacity.

In the study, various techniques were developed that are unique to this method of alloy preparation. A helium-gas-quenching method is described that minimizes contamination and segregation. The helium gas is precooled with liquid nitrogen to provide a faster quenching rate. Aluminum and pure metals with higher melting points, such as zirconium, titanium, and vanadium, have been quenched to solid state by this technique.

It was found that the levitating-melting technique is an ideal method for the preparation of alloys for Mossbauer studies, which require the addition of a small quantity of a specific isotope. For example, small quantities of Fe^{57} were successfully added to vanadium and palladium to produce a homogeneous distribution of the isotope.

Various solid-solution and intermetallic compounds were prepared. The levitation melting produced homogeneous alloys unobtainable by nonconsumable arc-melting techniques.

Notes:

1. Details are given in a report, "Levitation Melting of Metals and Alloys," by J. W. Downey, ANL-7398, December 1967, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151 for $3.00 (microfiche copies, $0.65).
2. Levitation melting has been used for numerous purposes including alloy preparation, vaporization studies, determination of the densities of liquid metals, and determination of the thermodynamic properties of alloys.

(continued overleaf)

3. The information may be of interest to research metallurgists.
4. Inquiries concerning this innovation may be directed to:

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Reference: B69-10006

Source: J. W. Downey
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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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