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TECHNICAL PROGRESS REPORT

Co-3311-1

FORMING OF COMPOSITE FOR SUPERCONDUCTING ROD

U. S. Atomic Energy Commission Contract AT(11-1)-3311

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Technical

Composite materials have many desirable and interesting possible engineering uses, provided fabrication problems can be solved. The goal of the present program has been to solve the problems involved in fabricating a composite wire composed of a hard core surrounded by a soft sleeve. Because of possible application in superconducting magnets, the particular materials studied were niobium-44 wt % titanium as a core surrounded by aluminum as the sleeve.

During the current contract year, a significant effort was devoted to determining the effect of core-to-sleeve ratio on the production of sound product for the case of aluminum-clad niobium-44 weight percent titanium rod. Extensive work was done with 1100 aluminum (commercially pure) because of cost. See Figures 1, 2, and 3 for sample data. In these figures the results of extrusion runs are shown as a function of percent reduction in area and core-to-sleeve diameter ratio. Conditions for successful extrusion are indicated as well as the type of failure if the extrusion was not successful.

It was established that for a given die angle there exists an optimum range of core-to-sleeve ratios for sound flow and that this range decreases as the die angle increases. Further, it had been established previously that, at a given die angle, the range of sound flow increases as bond strength increases.

The information thus obtained was used in extruding the same core material with higher purity aluminum (99.995%). It was found that the region of sound product for the higher purity aluminum was inside of the previously established range for 1100 aluminum and smaller in extent. Once a set of operating parameters was determined for the higher purity

aluminum (see, for example, point 3 in Figure 1), work was concentrated on making successive reductions using these same parameters rather than delineating the sound product region in detail. It was found that an annealing step was necessary after each two successive passes for the conditions indicated as point 3 in Figure 1 in order to continue reduction.

The single-cored rod is produced by drilling an aluminum rod along its axis and inserting the core. Presently work is being directed toward producing enough single-cored rod so that multicored rod can be made by inserting seven single-cored composites in a drilled aluminum rod and then inserting seven of the composites thus made in a drilled aluminum rod to make a forty-nine core composite, and so on.

It is planned that some of these multicored rods will be completed before the end of the current project year so that measurements of the properties of these materials as superconductors can be made. Brookhaven National Laboratory has very graciously consented to make a reasonable number of these measurements.

It should be noted that, in addition to the theoretical significance, the present work represents an advancement of the art in being able to work a very soft material and a very hard material simultaneously to achieve extensive deformation without failure.

Personnel

Dr. Avitzur has devoted 33.3% of his time to this project and Dr. Hahn has devoted 25% of his time. If it is necessary to conserve funds for the remainder of the project year, Dr. Avitzur will be paid from non-project contingency funds, but will continue to work on the project as in the past.

Technical Reports and Publications
During the Period Supported in Whole or in Part
by AEC Contract AT(30-1)-4078

Technical Reports -

1. "Forming of Tubes by Hydraulic Pressure," by Gordon Powell and Betzalel Avitzur.
2. "Void Behavior as Influenced by Pressure and Plastic Deformation," by Kurt J. Kahlow, under the supervision of Betzalel Avitzur.

Publications -

1. "Hydrostatic Extrusion of Hard Core Clad Rod," ASME paper #71-WA/PT-9, Transactions of the ASME Journal of Basic Engineering.
2. "Brittle-to-Ductile Transition Induced by Environmental Pressure," by Boaz Avitzur and Betzalel Avitzur, Proceedings of the 26th National Conference of Fluid Power, Vol. 24, pp. 358-368, 1970.

Copies of all the above reports and publications have been forwarded previously to AEC. It should be noted, also, that the paper "Hydrostatic Extrusion of Hard Core Clad Rod" was presented by Dr. W. C. Hahn at the Winter Annual Meeting of ASME in November 1971 in Washington, D. C.