AEC-NASA TECH BRIEF

Glassy Materials Investigated for Nuclear Reactor Applications

Studies were made to determine the feasibility of preparing fuel-bearing glasses and glasses bearing neutron-absorbing materials for use as crystalline fuel and control rods for reactors. Primarily, the properties which would determine the usefulness of the glasses as a reactor fuel were investigated—namely, devitrification resistance, urania solubility, and density.

A preliminary study was made of the effects of urania additions on some properties of selected glasses in the systems $PbO-Na_2O-SiO_2$, $Na_2O-CaO-SiO_2$, Na_2O-SiO_2, and $NaO-K_2O-SiO_2$. Primary areas of possible application investigated were: (1) glass containing fissile material as a single-phase fuel, (2) glass containing one or more high-thermal-cross-section materials as a single-phase control material, (3) glass as a dispersion medium or bonding agent in admixture with crystalline high-cross-section control materials, and (4) fissile-glass as a dispersion medium and sintering agent in admixture with crystalline fissile materials. Some work has been done on glassy coating materials for irradiation chambers and for neutron absorbers.

For application as a reactor fuel, a glassy material should have these general characteristics:

1. The glass should contain as high a content of fissile material as possible.
2. The glass should have a softening point below the operating temperature.
3. The glass should retain integrity as a solution, without a tendency to crystallize, for long periods of time within the operating-temperature range.
4. The glass must be compatible with the jacketing metal, since they will be in intimate contact during operation.

Fabrication methods were devised to form crystalline-glass mixtures of usable densities. Shapes were formed by pressing and sintering, warm pressing at 600°C, vibratory compaction and sintering, and extrusion at 800°C. A control-rod loading was fabricated by vibratory compaction of B_4C-glass into the cladding. Induction heating was used to bond the materials in the cladding tube. Glass-bonded uranium dioxide samples were prepared for Doppler-coefficient measurements.

The study revealed the most promising glasses to be based on compositions in the system $Na_2O-K_2O-SiO_2$. Compositions containing equivalent to about 60 w/o UO_2 were melted to single-phase glasses at 1500°C. Glasses containing up to 30 w/o UO_2 were extremely resistant to devitrification. Several compositions within this maximum range were maintained for 14 days in a gradient of 300°–950°C without crystalline development. One sample containing approximately 20 w/o UO_2 has been held in the same temperature gradient for 100 days without devitrification.

The work done on glassy coating materials for irradiation chambers involved the development of a technique for obtaining a uniform glaze on the inside of a porcelain tube, in which Sr^{90} would be used as the source of beta emission. The hazards involved in handling Sr^{90} prevented the use of the usual spraying or dipping technique for glaze application.

A uniform glaze was achieved by simultaneously rotating the porcelain tube and adding the glaze through a pipette. After the tube was rotated for a predetermined time, the excess glaze was drained out and an Sr^{90} solution was introduced through a calibrated pipette. Following the Sr^{90} addition, a blast of hot air was directed against the outside of the tube,

(continued overleaf)

while rotating, to speed drying and to reduce exposure time. The glaze was then fired in a sealed furnace chamber.

Complete details of this investigation are contained in *Glassy Materials for Nuclear Reactor Applications,* by E. D. Lynch, ANL-7062, November 1965, Argonne National Laboratory, Argonne Illinois. Copies of this report are available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price $3.00, microfiche $0.65.

Note:

Inquiries concerning this innovation may be directed to:

Office of Industrial Cooperation
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
Reference: B68-10103

Source: E. D. Lynch
Metallurgy Division
(ARG-10075)

Patent status:

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

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439