NASA TECH BRIEF
Marshall Space Flight Center

Boron-10 Loaded Inorganic Shielding Material

A new shielding material containing boron-10 and gadolinium for neutron absorption has been developed to reduce the interference from low energy neutrons in the measurement of a fission neutron spectrum using a Li^6 fast neutron spectrometer. The material is inorganic which reduces the distortion of the fast neutron spectrum caused by interactions with hydrogen in the boron-loaded epoxies and other organic materials commercially available. The material contains high concentrations of good neutron absorbers, approximately 80% boron-10 and 8% gadolinium oxide by weight. Epithermal as well as thermal neutrons are absorbed. The highest concentration of boron commercially available is 45%. The material also has good structural integrity and does not sublime in a vacuum as does cadmium, another good thermal neutron absorber. It also has a high melting point.

A 130 gram quantity of boron enriched to 92% in the isotope B^{10} was used along with 13 grams of Gd_2O_3 to shield a spectrometer head with less than a 1 cm thickness of shielding material surrounding it. A bare gold foil and a cadmium-covered gold foil were placed inside the shield to determine its effectiveness. Then the shield was placed in a high flux inside the empty beam port of an advanced TRIGA reactor at a distance of approximately 2 feet (0.6 meter) from the core. The neutron activation of the bare gold foil was reduced 6000 times and that of the cadmium covered foil reduced 50 times compared to the activation without the shield. Thus, the shield was highly effective against both thermal and epithermal neutrons. Amorphous natural boron powder actually produced a structurally stronger end product than the crystalline B^{10}. However, it is probable that the same result could have been obtained using a finer mesh B^{10} sample.

Monoaluminum phosphate, ($Al(H_2PO_4)_3$, a 50% solution in water) is used as the inorganic binder, and the procedure for manufacturing the shield is as follows. The boron, gadolinium oxide, monoaluminum phosphate, and water are mixed in the ratio 5:0.5:3:2 by weight, respectively, placed in the desired container, and heated to 93° C until two-thirds of the volume of a monitor solution containing only monoaluminum phosphate and water has evaporated. Then a plunger is used to force out the excess liquid by pressing the sample at 55×10^6 N/m^2 (8000 lbs/in^2). During the pressing, a quantity of monoaluminum phosphate sufficient to raise the boron concentration to between 75 and 80% is extracted. Depending on the application, the sample is either left in the container or extruded. In either case, a clamp is applied to prevent distortion upon heating. In order to activate the binder, the sample is placed in a 215° C oven for one hour, the temperature is raised to 260° C for 1/2 hr, and then the oven is turned off. The clamp is removed after the sample has cooled to room temperature.

Although the preparation of containers and plungers for pressing is inconvenient and expensive, the density of the finished product is increased. Typically, densities greater than 60% of the theoretical density are obtained using 55×10^6 N/m^2, and even greater densities should result from pressing at higher temperature and pressure.

Note:

No further information is available. Specific questions, however, may be directed to:

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(continued overleaf)

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NASA has decided not to apply for a patent.

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