

# NASA TECH BRIEF

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## Fire Retardant Polyisocyanurate Foam

### The problem:

To increase the fire retardant properties of low-density polymer foams.

### The solution:

A polyisocyanurate foam with pendant nitrile groups which form thermally-stable heterocyclic structures at a temperature below the degradation temperature of urethane linkages.

### How it's done:

The nitrile groups are introduced as acrylonitrile grafted to a low-hydroxyl number polyol prepolymer which may be of the type typically derived from glycerin and propylene oxide. Because the modified polyol has a low hydroxyl number and low functionality, the resulting polyisocyanurate-polyurethane foam structure has mechanical flexibility, whereas the polyisocyanurate polymers do not. The polymeric structures containing nitrile groups cyclize at low temperatures to form nitrogen-containing heterocyclic ring structures; subsequent degradation of these structures and the polyisocyanurate-urethane structures at an elevated temperature provides a high char yield, implying a correspondingly lowered yield of the volatile flammable species which are formed in comparatively large quantities by state-of-the-art polyurethane polymer foams based on polyols such as sucrose and glucose.

The new type of rigid foam is typically prepared by homogenizing in a ball mill a mixture of the polyol grafted with acrylonitrile, a tertiary amine catalyst, an inorganic base, a char stabilizer such as potassium fluoborate, and a blowing agent. Grinding is continued

until all dispersed solids are reduced at least to a diameter of  $50 \times 10^{-3}$  mm. It may be desirable to incorporate other polymeric materials (such as poly(vinyl chloride-vinyl acetate) copolymer) and inert refractories such as silica to increase density or to impart particular properties to the finished foam; other additives may be materials such as encapsulated flame retardants, cell stabilizers, colorants, etc. The premix formed by milling is then blended rapidly and thoroughly with a polymeric isocyanate, for example, a polymethylene polyphenyl isocyanate, and immediately poured into a mold to cure for about 16 to 24 hours.

When exposed to a JP-4 fire at a heat flow rate of 10–13 Btu/ft<sup>2</sup> sec ( $11.1 - 14.8 \times 10^4$  W/m<sup>2</sup>), 5-cm thick state-of-the-art polyisocyanurate foams burn through in about 55 seconds; in contrast, the new type of polyisocyanurate foams withstand burn-through for more than 600 seconds.

### Reference:

Riccitiello, S. R.; Fish, R. H.; Parker, J. A.; and Gustafson, E. G.: Development and Evaluation of Modified Polyisocyanurate Foams for Low-Heating-Rate Thermal Protection. *Journal of Cellular Plastics*, vol. 7, no. 2, page 3, 1971.

### Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer  
Ames Research Center  
Moffett Field, California 94035  
Reference: B72-10269

(continued overleaf)

**Patent status:**

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

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