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NASA TECH BRIEF

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Flame Resistant Elastic Elastomeric Fiber

The problem:

Various applications in space exploration require elastic fibers which resist burning in oxygen enriched environments. Commercially available elastic spandex fibers are made from urethane cores and are wrapped with flammable organic fibers. They are flammable both in air and in higher oxygen environments; addition of fire retardants typically degrades both the elastomeric properties and the processability.

The solution:

Three general flame retardant compositions have been developed which exhibit respectable elastomeric properties and yet possess various degrees of flame resistance.

How it's done:

One of the developed materials is polyurethane incorporating a halogen containing polyol and is flame resistant in air. The second material contains spandex elastomer with flame retardant additives; it is flame resistant in a moderate oxygen environment (35 percent oxygen). The third material is prepared from a fluorelastomer composition consisting of a copolymer of vinylidene fluoride and hexafluoropropylene, and is flame resistant in high oxygen environments (70 percent oxygen).

In preparing the polyurethanes where the polymer backbone includes a halogen-containing polyol, a number of polyisocyanates can be employed. The preferred polyisocyanates are 4,4′ diphenylmethane diisocyanate and arylene diisocyanates, having each of the two isocyanate groups attached directly to an aromatic ring, as, for example, toluene diisocynates.

The other main constituents of the polyurethanes chemically incorporated into the backbone are polyols containing halogen groups, the reactive groups of the polyols being hydroxyl groups. In general, the preferred halogen-containing polyols are those with bromine, derived from dibromoneopentyl glycol and tetrabromophthalic anhydride.

In imparting flame retardancy to the polyurethanes, the "soft" segment of the polymers is modified by forming it from the halogen-containing polyols. This can be accomplished in several ways. In one method, the halogen-containing polyol can be reacted with a difunctional acid, such as adipic acid, to produce a hydroxy-terminated polyester, which can, in turn, be reacted with a polyisocyanate to form an isocyanate-terminated polyester prepolymer. In another method, the halogen-containing glycol can be reacted with the polyisocyanate to produce a material containing isocyanate (NCO) groups, which can, in turn, be reacted with polyether glycol or polyester glycol to produce the polyurethane prepolymer.

On the other hand, flame-retardant elastomeric compositions, employing a spandex-type polyurethane, can be produced from a formulation containing 15 to 25 percent of the spandex-type polyurethane, 50 to 60 percent of hexabromobenzene, and 20 to 30 percent of tris 2,3-dibromopropylphosphate. Flame-retardant compositions containing fluorinated elastomers can be made from a formulation containing 45 to 50 percent of fluorinated elastomer and 45 to 50 percent decabromobiphenyl.

In preparing fibers or filaments from the elastomeric compositions, several methods can be employed, depending on the nature of the elastomer. In the case of polyurethane compositions of the conventional spandex type containing fire-retardant additives, or of the type where halogenated polyols are incorporated into the polymeric backbone, a wet spinning technique is the best approach. For fluorinated elastomer compositions, melt extrusion has been found to be best. The resultant fire-retardant elastomeric compositions, when formed into fibers wrapped with fire-resistant yarns such as polybenzimidazole, can be woven or knitted into fabric structures which will exhibit good strength and recovery characteristics and will have excellent fire-resistant behavior.

(continued overleaf)

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $5.25
(or microfiche $1.45)

Reference: NASA CR-128505 (N73-32464), To Improve the Flame Resistance of Spandex Elastic Elastomeric Fiber

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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