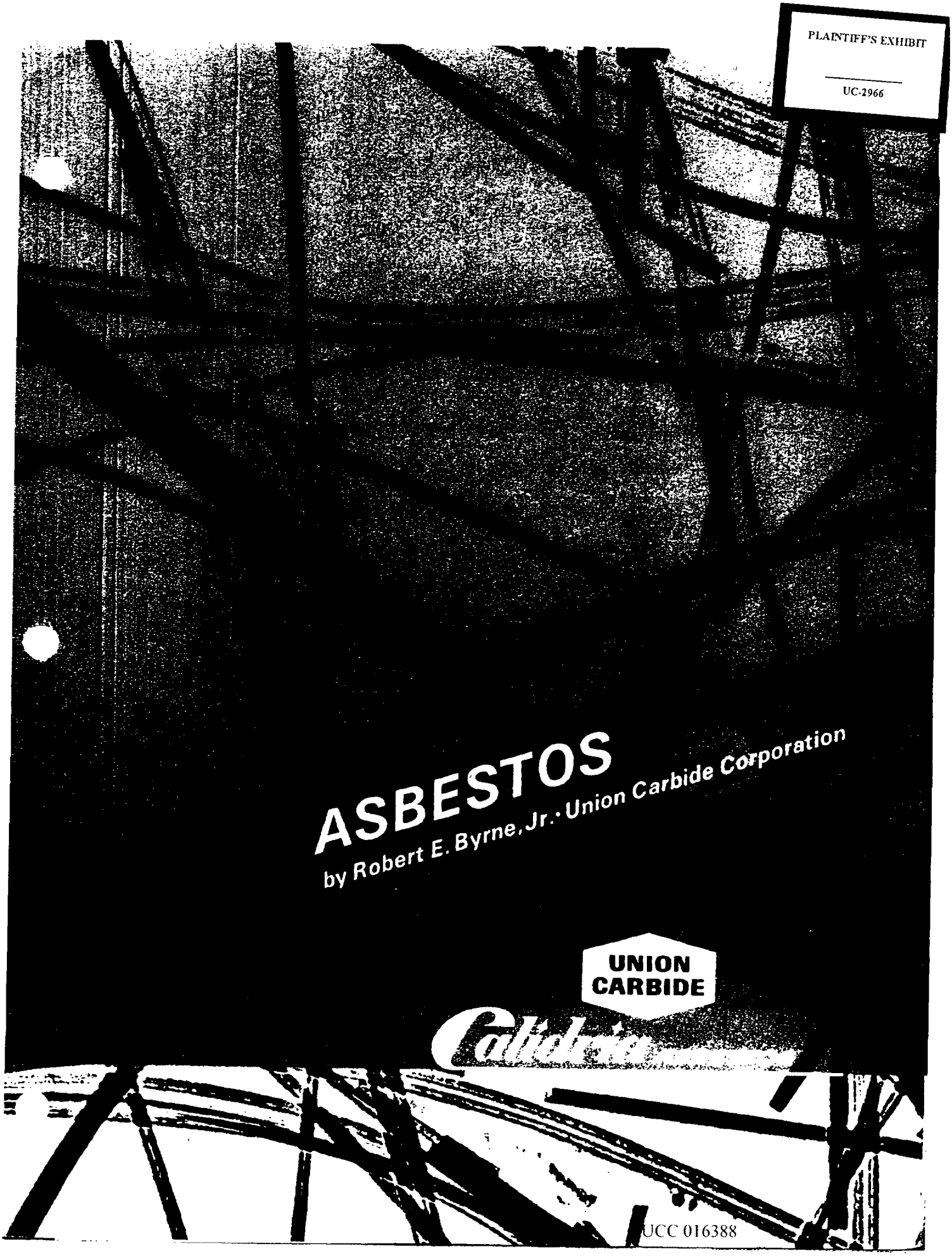


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Asbestos

By Robert E. Byrne, Jr.*

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Asbestos is a commercial term used for six naturally occurring "asbestiform" minerals that are fibrous, hydrated metal silicates. They include the fibrous form of serpentine, known as chrysotile, and five minerals of the amphibole group: anthophyllite, crocidolite, actinolite, tremolite and amosite.

Chrysotile is the most plentiful and useful form of asbestos. Of the more than 2 billion lb. of asbestos used each year by the plastics industry, about 93% is chrysotile. Its positive surface charge, softness and flexibility, and its low refractive index set it apart from other asbestos. Chrysotile's fiber diameters, less than 0.03 micron, are the smallest among commonly known fibers, and the material has exceptional mechanical strength.

Commercial products based on chrysotile have been introduced which, by chemical modifications of the normal chrysotile fiber, have novel surface properties. These materials are used mainly for viscosity control in antisag and thixotropic applications.

Compared to chrysotile, amphibole fibers are larger in cross-section, harsh, and hard. The amphibole asbestos minerals are anionic in surface charge, and are more resistant to acids than is chrysotile.

Anthophyllite fibers usually occur as fibrous masses containing randomly oriented cubic blocks of fiber up to an inch in length. They are generally used in insulating materials, as filtering media, and as fillers in plastics, paints, and asbestos-cement products.

Crocidolite, or blue asbestos, is found principally in South Africa. Needle-like in structure and possessed of exceptionally high mechanical strength, it is used in plastics, where its pronounced color is not detrimental.

Tremolite and *actinolite* are very similar, except for the higher iron content of the latter. Both are in relatively short supply, and are used mainly as filter media or fillers. *Amosite* is a long yellowish-brown fiber that is harsh and brittle, and is used mainly in thermal insulation.

Low cost, exceptional mechanical strength, and heat resistance account for much of the increasing usage of asbestos in plastic products. It has recently been recognized that the unit chrysotile fibril is a naturally occurring reinforcing whisker. Because of its high strength, stiffness, and aspect ratio, it provides excellent whisker reinforcement. Maximum utilization of these reinforcing potentials, however, requires a high degree of fibril liberation and the absence of extraneous gangue material. Some caution is necessary in selecting a product providing the optimum in these characteristics.

Asbestos is usually graded on the basis of fiber lengths separated by dry screening. While the different grades cannot be precisely characterized by a specific length, grades 2 and 3 are the

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ASBESTOS products for plastics

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- ✻ Low Moisture
- ✻ Less Dust

CALIDRIA Asbestos RG-244

a chemically modified, high-purity fiber with a mineral coating

- for maxmum thickening efficiency and thixotropy in polyester spray-up and hand lay-up laminating resins and gel coats.
- effective thickener for plastisol and organosol adhesives, coatings, mastics, and sealants as well as epoxy and phenolic adhesives.

Advantages:

- Permits high viscosity at low loadings, reducing costs.
- Wets out quickly and disperses easily.
- Improves shelf life, reduces settling.
- Does not add color or opacity at normal loadings.
- Reduces dusting from material-handling operations.

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a high-purity asbestos fiber without coating

- efficient, low-cost thickener and thixotrope for epoxy, vinyl, and phenolic resins; butyl, polysulfide, and other sealants; and casein adhesives.
- excellent reinforcer for rigid vinyl, nylon, polysulfone, and similar compounds.

Advantages:

- Thickens both epoxy resins and amine hardeners at 1/6 the cost of pyrogenic silica.
- Wets out quickly and disperses easily.
- Has no shear sensitivity.
- Improves shelf life, reduces settling.
- Reduces dusting from material-handling operations.
- Eliminates need for viscosity build-up or thixotropic stabilization additives (except for low viscosity, cycloaliphatic epoxides).

For further information on this "new approach" to thickening and thixotropy, contact your nearest Union Carbide sales office, listed on the back cover.

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Table I. Comparative properties of asbestos minerals

Properties	Chrysotile	Anthophyllite	Crocidolite	Actinolite	Tremolite	Amosite
Composition	$Mg_3Si_2O_5(OH)_4$	$Mg_7Si_8O_{22}(OH)_2$	$Na_2Fe_3Fe_2Si_8O_{22}(OH)_2$	$Ca_2Fe_5Si_8O_{22}(OH)_2$	$Mg_5Ca_2Si_8O_{22}(OH)_2$	$(Fe,Mg)_7Si_8O_{22}(OH)_2$
Crystal habit	Fine, easily separable fibers	Prismatic crystals and fibers	Long brittle fibers	Prismatic crystals and fibers	Prismatic crystals and fibers	Prismatic crystals and fibers
Color	White, gray, greenish	Gray-white	Blue	Green	White, gray-white, greenish	Ash gray or brown
Texture	Soft to harsh, also silky	Harsh	Soft to harsh	Harsh	Harsh	Harsh
Flexibility	Very good	Poor	Good	Poor	Poor	Good
Hardness, Mohs	2.5–4	5.5–6	4	6	5.5	5.5–6
Fiber dia., Å	180–300	600–900	600–900	600–900	600–900	600–900
Tensile strength, p.s.i.	300,000–800,000	<4,000	400,000–600,000	<1,000	1,000–8,000	100,000–200,000
Modulus of elasticity, p.s.i.	23.2×10^6	—	27.1×10^6	—	—	23.6×10^6
Fusion pt., ° F.	2770	2675	2180	2540	2400	2550
Specific heat, Btu/lb./° F.	0.266	0.210	0.201	0.217	0.212	0.193
Surface area BET, m^2/g.	10–60	7	10	—	—	9
Specific gravity	2.4–2.6	2.8–3.1	3.2–3.3	3.0–3.2	2.9–3.2	3.1–3.3
Refractive index (mean)	1.51–1.55	1.61	1.7	1.63	1.61	1.64
pH	9.5–10.3	9.4	9.1	9.5	9.5	9.1
Electric charge in aqueous slurry	Positive	Negative	Negative	Negative	Negative	Negative
Resistance to acids	Poor	Very good	Good	Fair	Good	Good
Resistance to alkalis	Good	Good	Good	Good	Good	Fair

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Table II. Typical changes in resin properties with asbestos reinforcement*

Material	% change				
	Flexural modulus	Flexural strength	Tensile strength	Impact notched Izod	HDT, °F.
ABS	+130	−20	−5	−60	+16
Nylon 6	+170	+100	+85	+20	+200
Phenolic	+120	+50	—	+5	—
Polyethylene	+320	+30	+20	0	+72
Polyphenylene sulfide	+60	+100	+10	+100	+35
Polypropylene	+360	—	−4	+125	+25
Polystyrene	+110	+50	+20	−40	+18

*Optimum reinforcement usually requires 20-40% short fiber asbestos.

longest fibers and grade 7 is the shortest. In general, the longer fibers are more expensive.

One of the few important nonmetallic minerals imported into the U.S. from foreign sources is asbestos. About 10% of our annual usage is produced from domestic sources with a value of over $10 million. The remainder comes mainly from Canada.

Asbestos selection

Asbestos short fiber is normally used for reinforcement, heat resistance, and flow control of plastics, while the longer grades are used for reinforcement and heat resistance in the form of fibers, yarns, or textiles. Chrysotile, as noted previously, is normally chosen for most applications because of its plentiful supply and product uniformity unless the special advantages of another mineral are required. For example, anthophyllite has been employed for reinforcing polypropylene because it allows easier heat stabilization. Recent reports, however, show that this disadvantage of chrysotile can be overcome. One of the amphiboles may be selected also where the poor resistance of chrysotile to acids presents a problem.

The use of short fiber asbestos in plastics products requires adequate dispersion to achieve optimum results. Melt processing is most satisfactorily accomplished in high-intensity mixers such as the Banbury. Dispersion in liquid resin systems also requires high shear devices and maximum viscosity to allow the resin/asbestos mix to absorb maximum energy. The masterbatch technique should be employed wherever practical.

Asbestos use

The largest uses for asbestos in plastics are vinyl/asbestos floor tile and in phenolic compounds. It is also used in myriad other areas including polypropylene, polyesters, nylons, melamines, epoxies, silicones, and vinyls. It is used in product types, including friction materials, heat resistant and electrical components, sealants, and mastics. The applications for asbestos are a balance of some combination of these effects. For example, short fiber chrysotile is used in vinyl asbestos floor tile to improve heat strength and dimensional stability, but requires that particular attention be given to heat stabilization of the resultant product mix during processing.

Since 1965, the consumption of asbestos-reinforced polypropylene by the automotive industry has increased rapidly. This trend toward the use of short fiber products for reinforcement is dependent on the inherent strength and fibril geometry of asbestos.

The volume of short fiber chrysotile used in mastics, sealants, and adhesives of various types is increasing. From 5 to 60% asbestos is used in adhesives to reduce crazing, shrinkage, and embrittlement. Asbestos also reduces cost, increases bulk, and provides controlled penetration and resistance to heat in such adhesives as phenolics, urea, resorcinol, epoxy, nitrile and reclaimed rubber, and silicones. In mastics and sealants, asbestos provides toughness, flow, and penetration control, as well as reduced cost. The colloidal grades of chrysotile are reported to contribute additional performance and handling improvements.

Polyester premixes used to fabricate automotive parts, tractor and marine engine housing, and materials-handling bins and containers often contain short fiber chrysotile to provide flow control, improve surface appearances, reduce shrinkage, and lower cost. The new low-profile systems utilize asbestos for controlled shrinkage, improved mechanical strength, and heat resistance.

The amount of asbestos needed varies with the particular resin system and the fiber length, and degree of openness of the asbestos. Each system has an optimum level for maximum mechanical strength. For example, in phenolics about 25% is typical for asbestos floats, or as low as 5% colloidal chrysotile. Asbestos content may vary up to 60%, however, depending on the levels of chemical, thermal and impact resistance, and the electrical properties desired. Asbestos-filled phenolic and urea formaldehyde resins find use in many electrical applications where heat resistance is required. Asbestos-filled polyester and diallyl phthalate compounds are also used in electrical applications. The asbestos-containing compounds enable molding with exceptional accuracy, molding-in metal inserts easily, and mass producing intricate shapes difficult to fabricate from other dielectric materials.

Phenolic/asbestos laminates used for rocket flame tubes are one example of the increased demand for asbestos-reinforced systems brought about by space age requirements for heat, chemical, and shock resistance.

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