CHEMISTRY

Fibers and More Fibers

The field of fiber research continues to expand as it tries to meet the demands of man on earth as well as in space—By Ruby Yoshioka

➤ MODERN ALCHEMY is changing not base metals, but polymers into gold.

The manufacture of polymer fibers is one of today's fastest-expanding industries. With increasing demands for fibers for clothing, tires, space applications and a variety of other needs, the consumption of both natural and man-made fibers has increased by leaps and bounds during the last few years.

Not only polymer fibers, but fibers in general are under intensive research. High-temperature fibers, glass fibers, metal fibers, fibers for space, latex-impregnated fibers—all these and many more are keeping the fiber industry wide awake and busy with chemical companies competing with each other to see who will produce the next new fiber with better or more unusual characteristics.

A new high-temperature fiber made from polybenzimidazole (PBI) has just been announced by the Celanese Corporation, Summit, N.J., and is being tested for use in "moonsuits" or parachutes to withstand the extreme heat of reentry from space. The Union Carbide Company, New York, recently produced a stronger-than-steel fiber made from graphite and the Carborundum Company, Latrobe, Pa., is actively engaged in research on boron nitride to produce a heat-resistant yarn.

Continual Improvement

From the first crude cloth woven of grass to today's fine fabrics, man has been taking steps continually to improve the material in which he clothes himself. This desire of man to produce better and better textiles has involved the highest chemical knowledge and with each step forward, the technology becomes more and more precise and intricate.

The world of fibers has changed drastically since the times when all fabrics were made from natural fibers, such as linen, cotton, silk or wool. No longer does man need to depend completely upon plants and animals for clothing material. Chemistry has taken the place of nature.

The first big step in the expansion of the field of textile fibers to free man from the uncertainties of nature was the result of research by a French scientist, Count Hilaire de Chardonnet, who developed a process for making fiber from regenerated cellulose. This first man-made fiber to be made on a commercial scale, rayon, is now familiar in every household.

Once called "artificial silk" and considered cheap, rayon now has gained its own place and stands up under its own merits, not only among textiles, but in other areas as the tire cord industry, one of the biggest users of man-made fibers.

After the first production of rayon in 1889, other man-made fibers followed. In 1913, the first acetate continuous filament yarn was produced by the brothers Camille and Henri Dreyfus, founders of the Celanese Corporation of America, foremost producers of this fiber.

In 1938, the first completely synthetic fiber, nylon, was made by the Du Pont Company, Wilmington, Del. With the discovery of this process,

Celanese Corporation

PROVIDING A FINISH—A finish is imparted to the acetate yarn at Celanese Corporation in New York by slashing and sizing the fiber.

fiber production entered a new, a completely chemical phase.

Rayon and acetate fibers, both cellulosic fibers, are still dependent upon trees or cotton for the basic material.

Great impetus to the field of textile fibers was spurred by the creation of nylon, and, more recently, the polymer research of Nobelists Prof. Karl Ziegler of Germany and Prof. Giulio Natta of Italy. The field of synthetic fibers expanded rapidly and continues to do so with the formulation of one new fiber after another.

However, Dr. Donald H. Powers, consultant at Arthur D. Little, Inc., said at the 36th annual meeting of the Textile Research Institute in New York that with various classes of fibers already in existence, "imaginative designers will have enough to keep them busy, not for 10 years, but for 50 years."

He believes that no really new fiber introduced after 1965 will make a profit before 1975 due to the many pitfalls involved in the development of new fibers.

The synthetic fibers, such as nylon, polyester, acrylics, olefins and spandex are made up of giant molecules, or polymers. These consist of many monomers, or single molecules, of a simple substance linked together chemically end to end in long chains. The monomers are the structural units that determine the nature of the fiber. The formation of polymer chains may continue endlessly linking thousands upon thousands of structural units.

Chemists can add or subtract various molecular components to these long chains, allow the recurrence of certain chemical groups, control the length of the chain, cause cross-linking and branching, and add other chemical components to produce a wide variety of fibers with different properties.

Polyester fiber sold under various trade names such as Fortrel, Dacron and Kodel, was developed by Du Pont Company and is widely used in clothing. Because of its versatility and since most of its dyeing problems have been mastered, polyester is expected to make the biggest jump in consumption.

Acrylics, which are also increasing in demand, include among others the well-known Orlon, Creslan and Acrilan.

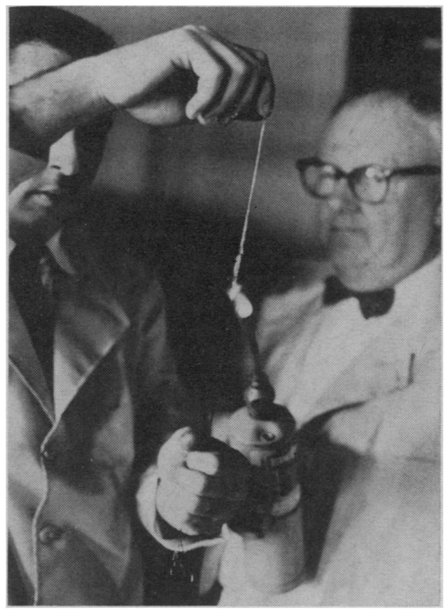
Another large class of synthetics, olefin fibers, primarily polyethylene and polypropylene, while not as suitable for making textiles for wearing apparel as the others, are widely used in the production of cloth for heavy wear, such as in outdoor furniture and auto seat covers.

Still another class is spandex, an elastomeric fiber in which the determining component in the polymer is polyurethan. Lycra by Du Pont belongs to this group.

The Fiber Identification Act of 1960 grouped textile fibers into 14 classes including the seven man-made fibers mentioned and the four natural fibers, silk, wool, cotton and bast (flax, hemp, jute, ramie and sisal). The others are glass fibers, metal fibers and a miscellaneous group which includes such fibers as fluorocarbon, rubber, saran and vinal among others.

Within each of these classes are countless variations of the basic fiber accounting for the wide variety of man-made fibers.

The man-made fibers can be produced either as staple (short-fiber) or continuous filament, and can be manufactured with a crimp, a high shrinkage or stretch built in. By special treatment a fiber can be adapted for soil resistance, resilience or wear comfort. Fibers of the different classes can be blended with each other, and dyes mixed in before spinning. With all these combinations to play with the possibilities for designing fabrics are virtually unlimited.



Celanese Corporation

SURVIVES FLAMES—Flames as high as 1000 degrees F. cannot burn this new superfiber called PBI. A product of Celanese Corporation, PBI is being tested for use in "moonsuits" or drogue parachutes to withstand the extreme heat of reentry from space.

Inorganic Fibers

Among the inorganic materials being investigated for use as fibers is boron nitride, on which the Southern Research Institute of the U.S. Department of Agriculture has been working for many years.

Boron nitride fibers, despite their high cost ($1,000 to $2,000 per pound), have a future in the textile field because of their light weight, resistance to temperature and high elastic strength. Their specialty may

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well be in aerospace applications where lightness and strength are of optimum importance.

The Carborundum Company has produced such a fiber which will withstand heat up to 4,500 degrees F. in an inert atmosphere. Although further research is necessary to produce a boron nitride fiber usable for textiles, the material has possibilities for use in military as well as firefighter's clothing. The fiber in addition is an extremely efficient neutron absorber which would make it useful as a shield from neutron radiation.

Union Carbide Corporation has produced an electrically conductive textile fabric, a composite of carbon yarn and insulating glass yarn, which has the flexibility and drape of glass fabrics with applications in heated clothing, bedding and cushions.

In this push-button age, people are constantly looking for short-cuts in their daily work. Ironing and washing are among the most time consuming and tedious chores for the housewife, who is therefore eager for any invention that will minimize these tasks. For this reason, one of the newest processes in fiber manufacture, known as durable-press, is a welcome one.

In durable-press the bolt of cloth is impregnated with a cross-linking agent that comes into play after the garment is cut and sewn. Creases, seams and pleats are then pressed into the material. The cross-linking chemical takes action, locking the creases into place for the life of the garment.

Closely observing the desires of the housewife, the manufacturers of man-made fibers are designing their products to fit consumer needs. Thus nonstaining hard-wearing synthetic fibers have wide appeal. In the carpet market, they are fast becoming dominant because of these qualities. Significant among these fibers are the nylons, acrylics, polypropylenes and polyesters. Sales to carpet makers of man-made fibers have almost doubled in the past two years and are expected to increase even more.

Two-Component Fiber

The Allied Chemical Corporation, New York, has gone a step further in fiber synthesis with their development of a new two-component fiber process. Research by their scientists has shown that it is possible to combine two fibers before spinning by controlling the chemical interaction between them. Experiments were done with polyester and nylon as constituents and a material was devised which when melt-spun resulted in a new fiber system.

These new fibers were in effect, intimate mechanical mixtures in which the fibrils of one constituent were embedded in a matrix of the other, all in one single filament. By changing the proportions of each of the components, changes in the mechanical properties of the resulting filament can be produced. The possibilities of such tailor-made fibers are infinite.

In spite of the fact that production of man-made fibers has increased tremendously, cotton still retains its position as the "fiber king." More cotton is consumed yearly than any other single fiber.

However, to maintain its position in the textile market, cotton manufactors have developed various finishes to provide the fibers with such properties as wrinkle resistance, stretchability and stain resistance.

A new method of producing cotton fabrics with shape-holding properties has been devised by the Gagliardi Research Corporation. This involves cross-linking the cellulose molecules of the cotton fibers by exposing the woven fabric to various gas vapors.

An inexpensive treatment to give stretch to lace has been advised by scientists of the U. S. Department of Agriculture. The treatment called slack mercerization consists of soaking woven cotton lace in a solution of sodium hydroxide which causes the fibers to swell and crimp, thus providing stretchability as well as richness and depth.

A number of finishes developed by the USDA are now in commercial use. Stretchability and wash-and-wear in particular are expected to win back some of the market lost to man-made fibers.

Wool is also undergoing processes to improve its qualities. Wool that can be washed in a washing machine has been developed. The fibers are treated with a polymer which becomes chemically bonded to the wool molecules. The coating thus produced protects the wool from shrinking and pilling.

Finishes are equally important for man-made fibers. Static must be reduced, luster in rayons must be controlled, softness must be added to fiber glass fabrics. Permanent creases and other special properties are also the results of various finishes.

The volume and importance of textiles are growing. Three of the synthetic fibers are expected to dominate the fiber market—the nylons, polyesters and acrylics—within the next 10 years.

With the growth in population and the increasing demand for fibers in a variety of areas other than textiles, such as the automotive, building, paper and aerospace industries, fiber chemistry will continue to expand for many years to come, challenging the imagination of the creative chemist.

• *Science News, 89:389 May 21, 1966*