NYLON—ANOTHER MILESTONE IN THE HISTORY OF HOSIERY

Berkshire's Nylon Stockings made with the most Remarkable of all Synthetic Textiles to have Country-Wide Presentation Next Month

MAY 15th is the date set for the country-wide presentation of *Berkshire's* full fashioned hosiery made with nylon. With the widespread publicity that this fiber has been receiving the new stockings are assured of a very favorable market. In fact, demand will probably deplete the supply within the first day or two.

Despite wild rumors and exaggerated statements attributing qualities to nylon which would class it as a minor miracle, nylon stockings are destined to win favor with customers solely on merit.

The *Berkshire Knitting Mills* was chosen as one of the manufacturers to co-operate with E. I. duPont de Nemours & Co., Inc., in the early experimental work with nylon. For many months BKM technicians worked on sample lots of nylon stockings, subjecting them to our laboratory and wearing tests, making comparative tests with silk, and planning to fit the new yarn into our established operations.

Early this year when nylon became commercially available in limited quantities, *Berkshire* was prepared to switch from experimental to actual production immediately. Consequently a battery of 45 and 51 gauge machines (nylon will be restricted to 45 or higher gauges) have been running steadily preparing for the debut of nylon stockings next month.

Nylon, one of the most important chemical achievements of the last decade, was developed by the late Dr. Wallace H. Carothers, brilliant duPont chemist.

Nylon is the result of a long study of molecules. DuPont scientists were engaged in a study directed to a better understanding of how and why certain of the tiny building blocks or molecules of which all matter is made unite to form "giant" molecules, such as found in rubber. Chemists have long been vitally interested in this subject of giant molecules—technically known as "superpolymers", and in learning everything possible about the mechanism of what the chemist calls "polymerization", which, after all, means only the process by which large molecules are formed from small molecules.

MICROSCOPIC CHARACTERISTICS

. . . a cross section (many times enlarged) of silk and nylon filaments. To the left is silk with natural but irregular fibers. Nylon filaments (right) are circular, extremely uniform in their diameter and have smooth contours.

Out of this study (begun in 1928) it was demonstrated that certain small molecules could be made to unite in such a way as to form giant molecules of great length,—so-called linear superpolymers, the small molecules being joined together end to end like a chain of ordinary paper clips. Such long molecules occur in nature. The rubber molecule is one of the longest chains of atoms known to chemists.

After this study had been under way for about two years, one of the chemists in the Carother's group pulled a sample of molten material from a still and noticed that it could be drawn out like a fiber of silk. And, extremely important that the fiber after cooling could be stretched again to several times its original length.

This was merely a prelude to success. It, however, suggested the possibility that some related type of superpolymer might give fibers which would possess the characteristics for use in textiles.

Years of research continued; at one time the outlook was so dark consideration was given to suspending this particular line of applied research. Finally a superpolymer of a different type was prepared, known as a "polyamido", from which fibers spun by hand were found to possess such characteristics as to warrant extraordinary efforts to bringing the development to a commercial success. Then came the day when a compound was formed into an encouragingly good filament by squirting it through a hypodermic needle. Several years more of experimentation with hundreds of different polyamides before DuPont announced on October 27, 1938, the development of a group of new synthetic superpolymers from which, among other possible applications, textile fibers could be spun surpassing in strength and elasticity any previously known textile fiber.

Nylon was the name coined for the fiber. Nylon is officially and scientifically defined as "a man-made protein-like chemical product (polyamide) which may be formed into fibers, and other forms which are characterized when drawn, by extreme toughness, elasticity and strength."

The word "nylon" does not refer to any particular form of the polyamide any more than does the term "glass" refer to any particular form of glass. Nylon does not have reference to one particular chemical compound but rather to a family of related compounds—the polyamides, and they are many in number.

One particular type of nylon, now used in making *Berkshire* stockings can be made from dibasic acid derived from phenol, and a diamine likewise derived from phenol. Oxygen from the air is also needed in making the dibasic acid, and ammonia is used in making the diamine. Since phenol is commonly derived from bituminous coal, and since ammonia is made synthetically by causing the hydrogen from water to unite with nitrogen from

the air, it follows that this particular nylon is derivable from coal, air and water.

While it is of economic and industrial significance that nylon can be made from domestic raw materials such as coal, air and water of which there is an abundance—that's only part of the story. In order to make nylon from "coal, water and air", many intricate, chemical reactions must be carried out, involving elaborate and costly equipment.

One of the most interesting physical properties of nylon is that it can be drawn cold. This is an unusual property of crystalline materials. If a fiber of nylon which has been made under low tension is subjected to further tension, it can be drawn from four to seven times its original length, depending upon the particular polyamide being used.

A highly interesting phenomenon occurs during this stretching operation. The long, chain-like molecules which made up the undrawn fiber are arranged in helter-skelter fashion like the individual straws in a haystack, but on drawing this fiber to several times its original length, the long-chain molecules take on an orderly arrangement. They become parallel to one another and are brought much closer together.

But this particular behavior, known as "orientation" of the molecules, is more than an interesting phenomenon for on this property hinges the very important industrial value of nylon. The practical significance of this property particularly applied to textile fibers, is that, on cold drawing, nylon becomes exceedingly strong and elastic.

The superior strength of drawn nylon is due in part to the fact that the long oriented molecules lie so close together as to give rise to powerful inter-molecular forces which resist slippage of the molecules when tension is applied. Breaking of any material is due only to separation by force of the molecules that make up the material, and closely packed, parallel molecules like those in drawn nylon offer great resistance to separation.

Another factor contributing to the high tensile strength of drawn nylon is the extreme length of the molecular chain in nylon filament. Actually, the "extremely long" molecules in nylon are only about ten or twelve millionths of an inch in length—too small to be seen even through a microscope.

The switch from silk to nylon in the *Berkshire* knitting and finishing process was accomplished after considerable research and experimentation. In addition to the established operations necessary in the manufacture of full fashioned hosiery, a heretofore unknown process is involved in the making of nylon hosiery.

In order to maintain the smooth, even structure of the fabric as it comes off the knitting machine, it is necessary to subject nylon stockings to a steam pressure bath. This is done in a process resembling the regular boarding of full fashioned silk stockings.

As a result of this "setting" operation the beautiful shape of nylon stockings (just as they look when you buy them), will be retained throughout the entire life of the stockings regardless of the number of times they are laundered. This process determines to a large extent the final appearance of the stockings and is the controlling operation on nylon.

THE ACTIVE LEGS OF TODAY'S WOMEN

. . . demand the sheerest hosiery and, inconsistently enough, wear and serviceability. Berkshire stockings made with nylon, distinguished by high elasticity, great strength, excellent wearing qualities and good appearance, will come nearer to fulfilling those demands than any other stockings made heretofore with any other fibers. Above, Berkshirette Olive Buller subjects her nylon stockings to the rigors of modern dancing with success.

The extraordinary uniformity of this new polyamide fiber is reflected in its lustrous, silky appearance and seems to obviate the necessity of using the three-carrier method of knitting.

Nylon stockings have excellent wearing qualities—they are extremely tough. In fact there is a tendency to lighten the heel and toe reenforcements because of nylon's quality of "toughness." They dry rapidly after laundering and may be washed repeatedly with no material change in their original shape and smooth characteristics. They are virtually wrinkle-free and are, under ordinary conditions, crease-proof. They are practically the same strength when wet as dry and will not lose their shape. They will not burn, the fibers actually melt then fuse to a glassy globule.

The beauty of nylon hosiery is unquestionable and tests carried out with several thousand pairs of experimentally produced stockings tend to confirm their excellent wearing qualities.