foundations at least once a year for mud tubes of termites.

Practically no U.S. research has yet been completed dealing with the Formosan termite, discovered in 1966 in some southern port cities. Experience with related species encountered in the Canal Zone tests suggests the chemicals recommended above will be effective, but that the concentrations would have to be doubled. The Department of Defense has reported that a 2 percent water emulsion of chlordane has been effective on the Formosan termite in Guam.

As of January 1, 1968, no chemical has been registered for use specifically against the Formosan termite.

The researchers at Gulfport are looking for still better soil chemicals, and they are also studying the life history and habits of termites, both domestic and Formosan. They hope to find biological controls, such as diseases. Possibly they can discover an attractant that can be used as bait. Perhaps they can find a weak point in the insect's life cycle.

Right now, though, chemically treating the soil under and around foundations is the best method of preventing or controlling attacks in buildings. If architects, builders, and homeowners would insist on such treatment, then we could truly say, "Off limits, Mr. Termite."

*For further reading:*

St. George, R. A., Johnston, Harmon R., and Kowal, R. J., *Subterranean Termites, Their Prevention and Control in Buildings.* Home and Garden Bulletin 64, U.S. Department of Agriculture, Washington, D.C. 20250, 1963.

# WURLAN—*Wool Fabric for Modern Living*

ELEANOR C. TAYLOR

When you describe something as "all wool and a yard wide" you mean it is genuine, good, desirable. Wool fabrics have long been the standard of excellence, and they still are, but they have also been called a luxury. Frequently, however, it is not the cost, but the upkeep which has labeled them so.

Now chemical modification treatments of wool fibers are changing this picture. Wool treated by these processes can be machine washed and, after tumble drying, the garments need only a light pressing, so drycleaning costs can be eliminated. On the horizon are wool fabrics that need no ironing, and have excellent soil resistance.

Between 1960 and 1966, wool machine-washable children's clothes, men's shirts, robes, blankets, socks, housecoats, sweaters, and women's dresses appeared in stores all over the country. Fabrics treated by one of the processes, called the WURLAN process, were adopted by more than 100 apparel manufacturers. They sell the WURLAN-treated products under many trade names.

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Alanna Crimmins, Miss Wool of America, 1967, admires WURLAN-treated fabrics displayed by Dr. Harold P. Lundgren.

How did it come about that so many companies all used a single process? No one of these companies invented the WURLAN process nor did any single individual. No nationwide publicity campaign launched the WURLAN fabrics—the usual procedure with a new product. Who, then, did invent WURLAN, and how did it spread so rapidly through industry?

The answer lies in team research conducted by a public agency for the benefit of consumers and in response to the needs of an important segment of our economy.

In the late 1930's, textile manufacturers began to shift over from using natural fibers (especially wool and cotton) to using the new synthetic fibers. By the late 1950's, wool consumption had decreased slightly, while consumption of synthetics had increased eightfold. This change was a serious threat to our domestic wool producers. They realized that something had to be done quickly or they would be out of business.

Manufacturers of synthetics were spending hundreds of millions of dollars on research and promotion, and customers were delighted with many features of the new fabrics made of synthetics—especially their easy care features. But wool remained the standard of excellence because of its durability, comfort, excellent tailoring qualities, and elegance for stylish clothing. Perhaps the market could be recaptured if wool could compete with synthetics on the basis of easy and inexpensive maintenance.

Representatives of the wool-producing industry appealed to the U.S. Department of Agriculture, and USDA responded by starting a vigorous research program. Since the late 1950's, the Wool and Mohair Laboratory under the direction of Dr. Harold P. Lundgren at Albany, Calif., has been grinding out one discovery or development after the other, all leading to better knowledge of the wool fiber and better quality in wool products.

The laboratory is part of the Western Utilization Research and Development Division of USDA's Agricultural Research Service. And all discoveries are available without fee to the U.S. textile mills.

When the research program started, the most urgent need was to eliminate shrinkage of wool during washing. A logical approach was first to find out why wool shrinks, then to learn how to prevent the shrinkage. Proceeding in that direction, the scientists undertook studies of what the wool fiber is composed of, how it is put together, and how it behaves under different environmental conditions. Sophisticated modern analytical instruments and techniques were available, and they were applied to answering these questions. The objective was to learn how to design and produce, in a highly scientific manner, the desired fabric qualities. Fortunately, wool is a protein substance that lends itself readily to chemical modification, so it should be possible to tailor it chemically to meet the requirements of the mills and the consumers.

The fact that the surface of the wool fiber is covered with overlapping scales all pointing in one direction was a clue to shrinkage. When the wool fiber is wet it softens. As the fibers slide along each other, they tangle together and are held that way, probably by the scales. This is called "felting." If the scales could be smoothed off or a coating applied to cover them, the fibers might slide back to their original po-itions. Various coatings had, at times, been applied to wool fibers, but they left the fabric harsh and boardy. The need was for a coating that did not change the soft resiliency of the fibers, and one that would stick on through wear and washing.

Polymer chemists in the wool research group suggested that interfacial polymerization (IFP), a chemical principle which was then fairly new, might be applicable. A process employing the IFP principle was devised. Essentially this consisted of bringing together two chemicals in solutions that do not mix, but the chemicals react at the interface of the solutions to form a polymer, a compound having characteristics which are different from the starting materials.

The fiber chemistry team experimented with the many chemicals that can be used for this reaction. They found that when wool fibers were coated with one chemical and then dipped in another, the polymer formed on the wool fiber. The result was that the scales were covered over with an extremely thin layer of a nylonlike material—the experiments were successful. This procedure was the first practical application of the new IFP principle.

Next step was to develop methods to perform the process on a commercial scale. The pilot-scale textile mill at the Albany laboratory enabled development work to go forward at a rapid pace. Since many pairs of chemicals polymerize interfacially, a choice had to be made on the basis of cost, ease of handling in the process, and effectiveness of the treatment. The concentrations of chemicals in solutions, temperatures, immersion times, and many other variables were studied.

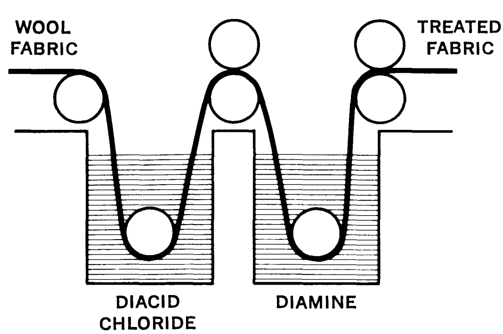
Results were most encouraging. The treating procedure turned out to be relatively simple. It could proceed at room temperature, no heat curing of the treated fabric was required, and the wool needed no pretreatment. Fortunately, some of the most effective chemicals were economically feasible.

Excellent resistance to felting shrinkage was achieved with relatively low polymer uptake—an advantage because of cost. Also, a heavy coating might change the texture and softness of the fabric. Although the coating is ultrathin, it survives through repeated launderings.

This new process was named WURLAN, a word coined from the initials of the *W*estern *U*tilization *R*esearch and Development Division combined with "lan" from the Latin word "lana" for wool.

Samples of treated fabric were sent to commercial textile mills for evaluation, and interest was immediate.

In WURLAN process, an ultrathin coating of a nylonlike material is grafted around each individual fiber in the wool fabric.



When several companies arranged to run plant-scale tests, Willie Fong and other members of the team who had played prime roles in pilot-scale development went into the mills to work directly with the engineers and operators. These trials, conducted in cooperation with industry, demonstrated that the treatment can go on in a completely satisfactory manner under mill conditions. Effective and uniform treatment was possible in continuous runs. The process could be integrated into the conventional wet-finishing routine; and the solutions were adequately stable to meet processing requirements. The process was ready for commercialization.

During this research and development sequence, testing and evaluation were important to every step. Had the fabric been damaged by the treatment? Did it retain its softness, resiliency, moisture-absorbing ability? Could it be dyed satisfactorily? Could it survive repeated washings and wear? Many tests were made by using sensitive complicated instruments, and some new instruments were devised. Members of the laboratory staff subjected the experimental garments to practical wear tests. They wore treated shirts, trousers, and socks under prescribed conditions and with a specified laundering schedule until the garments wore out.

Results of the testing showed that the WURLAN treatment not only reduced shrinkage to a minimum, but it had some bonus features. The treated fabrics had better abrasion resistance and resistance to forming small balls of fibers (pills) than did untreated wool fabrics, they were stronger, and they were somewhat more resistant to certain kinds of soiling. Treated goods could be steam pressed or dry pressed. Durable pleats and creases could be set into the treated goods by usual commercial techniques.

Over the years, many other shrink-resist treatments have been tried and several are in use. The earlier treatments weakened the fabrics or made them stiff and harsh. The WURLAN process was the pioneer in what are called "additive finishes." Since its development, other additive finishes have been developed in laboratories around the world, but WURLAN is still one of the best. In 1967, the German Wool Research Institute conducted an international competition for fabrics treated for shrink resistance. Wool fabrics with WURLAN processing placed first and were the only ones passing their most severe shrinkage test.

But good as WURLAN is, there is still room for improvement. New, cheaper chemicals have been found, and the processing methods are being improved.

A technique for applying the WURLAN treatment to wool top—as opposed to fabrics—has been developed. ("Top" is the assemblage of wool fibers from which worsted yarn is spun.) This technique allows the manufacture of machine-washable knitted goods,

**A USDA Chemist, Richard O'Connell, doubles as a "guinea pig" in the wear tests of WURLAN-treated socks, shirt, and slacks.**

which were very difficult to treat in finished form because they became distorted.

Need to press treated wool garments after laundering will soon be a thing of the past. True no-iron fabrics made from blends of the treated wool and modified cellulosic fibers are already on the market. The cellulosic component of these blends contributes its excellent no-ironing effect, while the wool gives the fabric esthetic values, wrinkle resistance, warmth, and resiliency. All-wool fabrics which require no ironing are now a major subject of research.

Cheap and long-lasting finishes to make wool fabrics oil repellent and water repellent may soon be available. New fluorine compounds discovered by Dr. Allen G. Pittman at the Albany laboratory confer repellency to oil, water, and the soils carried by oil and water. Several new families of fluoro chemicals have been prepared, and some of the most promising of these should be far more economical to make and use than any related materials now known.

Goal of the staff at the Wool and Mohair Laboratory is to find a single treatment which gives multipurpose benefits to wool. But even without a one-shot process, these various new treatments for wool are widening the scope of use for this elegant fabric. With soil resistance and wrinkle resistance, machine washability, and longer wear life, even children's clothes and apparel in delicate pastel colors are practical. We can have our luxury and afford to maintain it, too.

# *Frozen Foods—New Techniques*

J. G. WOODROOF

From field to dinner table, frozen foods have won a place for themselves. Farmers grow varieties of plants just for freezing. Equipment has been developed exclusively for harvesting, handling, processing, storing, and hauling frozen foods. Eating establishments routinely use hundreds of frozen food items. The housewife uses frozen foods in most of her meals.

One of the secrets in frozen food quality is quick freezing. The trend in preparing, storing, and using frozen foods has been to use lower and lower temperatures. This increases the rate of freezing, reduces labor costs, better retains the quality of food, and adds certain conveniences to using.

Before 1928, meats, fish, strawberries from the Northwest, and a few other foods were bulk "sharp frozen." The washed and graded products were packed in barrels or other large containers and placed at 0° F. until they froze. This kept them from spoiling and preserved the "freshness" fairly well—that is, better than heat-processed foods and those that laid on the fresh produce counter for several days. From many hours to a week was required for the foods to freeze solid.

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