DYEING OF IMITATION AND ARTIFICIAL SILK: BY PROFESSOR CHARLES PELLEW, OF COLUMBIA UNIVERSITY: NUMBER IX

OWING to the high price of pure silk and the bad wearing qualities of the highly adulterated silks described in my last article, there has been for a long time a strong demand for a fabric which would combine as far as possible the strength and wearing power of the one with the cheap price of the other, while still retaining the luster and "scroop" or characteristic feeling of both.

This demand at present is met, and not so unsuccessfully, first by imitation silk, of which mercerized cotton is the best example, and second, by the various forms of artificial silk which during the last few years have been introduced widely in both Europe and our own country. The competition of these two classes of products is not at all to be despised. Their quality is constantly improving, their price diminishing, and their production increasing rapidly from year to year. And if the silk manufacturers continue to produce such poor material in the line of weighted silk fabrics as they have in the past, it will be but a short time before they will find the market almost entirely divided between pure-dyed silks, on the one hand, for expensive goods, and some of these new products for cheap materials.

Mercerized Cotton.—This material was first introduced as a substitute for silk some ten or twelve years ago, although the process for making it was invented about 1840, by a celebrated English dyer, John Mercer. He discovered that when cotton, either in cloth or yarn, was subjected for a short time to the action of strong caustic alkali, and then thoroughly washed, the resulting material was much stronger than before, had shrunk very considerably, and had a much greater affinity for dyestuffs. For instance, dyes like the Basic Colors, which give but a temporary stain on ordinary cotton, will dye with some degree of fastness cotton thus treated with alkali, without the use of mordants. Mercer patented his discovery and made some use of it in calico printing; as, for instance, in the making of "crinkled" goods. But the process was nearly forgotten until, in 1889, it was discovered that by proper treatment cotton could by this means be made so lustrous as to compare not unfavorably with silk.

To make the cotton lustrous, the goods, after dipping into the strong alkali, are kept firmly stretched, and their strong tendency to shrink resisted, until the alkali has been thoroughly rinsed off and the last traces neutralized with a little acid. If this is done carefully, when finally dried the cotton fibers will be found drawn out smooth and lustrous, while still retaining their new qualities of strength and increased dyeing power. To get good results in this process the materials treated, whether in yarn or cloth, must be made of the very best and longest stapled cotton, preferably Egyptian, and when well done the results are extremely satisfactory. The luster is not as good as the very best silk, but it is quite well marked, and for replacing the cheap grades of heavily weighted silks, as, for instance, for underwear, linings, etc., the mercerized goods are of very great value, owing to their strength and durability, as well as their cheapness.

Dyeing of Mercerized Cotton.—The cotton thus treated is dyed in the same way that ordinary cotton is, only it takes the dyes faster and better, and gives as a rule more satisfactory results. For blacks, the Sulphur blacks are to be recommended, as, for instance, the Thiogene Black M M extra conc. (Metz), or one of the Immedial Blacks (Cassella). For bright colors, very fairly fast to light, the Direct Cotton Colors or Salt Colors, such as Benzo Fast Scarlet (Elberfeld), or the many fast Diamine Colors (Cassella), or the Dianil or Janus Colors (Metz). In factories they are often dyed with Basic Colors, usually after mordanting with tannin and tartar emetic. This, however, is

troublesome to do on a small scale, and unless very carefully managed is liable to injure the luster.

Artificial Silk.—The famous old French chemist, Réaumur, in the year 1734, suggested, after a study of the silk worm, and of the method by which it "spins" the natural thread, that it might be possible to make a jelly-like substance which could be drawn out into a fine thread and, coagulating, form an artificial silk.

This suggestion was first acted on, in a practical way, in the year 1855, when Andermars obtained some curious results by dipping a needle or fine metal rod into a thin viscous solution known as collodion, and then drawing it out rapidly, made fine smooth threads as the material solidified. This collodion, which for many years has been in common use in minor surgery to paint on wounds and cuts, because it leaves a film of artificial skin, and in more recent times has been much used in photography, is a solution of guncotton or nitrocellulose in a mixture of alcohol and ether. In 1885 Count Hilary de Chardonnet made improvements in this last process, and produced successfully the first real artificial silk threads on a commercial scale.

He also used a thick collodion solution, but instead of *drawing* it out he *pressed* it out through fine holes by using very great pressure. As fast as the gummy thread exuded it was picked up, carried along into a drying room where the alcohol and ether could escape (to be condensed later and used over again), and then the solid fiber was passed into a solution of some suitable reducing agent, such as ammonium or sodium sulphydrate, which converts the inflammable guncotton into its original condition of cellulose. These resulting threads, being smooth and uniform when properly made, have very great luster. Indeed, they are often far more brilliant than the very best and finest natural silk, and can be dyed and woven into beautiful fabrics.

This discovery of Chardonnet's was at once utilized, and large and flourishing factories of Chardonnet silk sprang up all over Europe. The first large factory, which is still doing a very profitable business, was at Besançon, in France, and later a large factory was established at Frankfort, Germany.

The success of this process aroused the interest of other chemists, and before long several rival processes came into existence, also based on the use of a viscous solution of a cellulose compound. One company making the so-called Pauly silk utilized the solvent action of an ammoniacal copper solution upon cellulose for their starting point. The Farbenfabriken von Elberfeld, famous manufacturers of dyestuffs, took up the manufacture of silk from a solution of a compound of cellulose in acetic acid; and the Elberfeld silk, or, as it is widely known in Germany, Glanzstoff, is every year becoming a more and more important factor in the silk business.

A still different process which during the past two or three years has been successfully introduced into the United States depends upon the curious substance called Viscose, a thick, sticky solution of cellulose made by first treating wood pulp, cotton or other vegetable fiber with strong caustic soda and then dissolving the resulting product in carbon disulphide.

This Viscose was first introduced for many different purposes. The solvent, carbon disulphide, is very volatile, and flies off readily, leaving the cellulose behind in the form of a stiff jelly which, on drying, becomes solid and strong. So Viscose was used for waterproofing paper, etc., for making solid articles like piano keys and billiard balls, and even for making opaque patterns in calico printing. But its most valuable application is for artificial silk. It is pressed out through fine holes, and the thread resulting quickly solidifies as the solvent evaporates, and can be dried carefully and worked up on reels or bobbins, to be dyed later.

The artificial silk, as a rule, is a little stiffer than natural silk, but has an exceedingly fine luster. It cannot be spun in as fine threads as fine natural silk, but on the other hand can be produced in

thick, smooth threads which, stained as a rule black or dark colors, quite replace horsehair for furniture coverings, etc. Similar products are made, too, by coating cotton with a layer of artificial silk.

Another curious use of this artificial silk process is when threads still thicker are made quite stiff and used for plumes and aigrettes. They can be dyed any color, have excellent luster, and are extremely useful for millinery.

One great drawback is common to all these different varieties of artificial silk. They are quite strong, although not particularly elastic when dry, but when wet lose their strength very markedly. Indeed, at one time it was found extremely troublesome to dye them, as the silk skein dyers, accustomed to work and wring and stretch their silk with impunity in and out of the hot dye baths, would try the same treatment with this new product, and in consequence ruin every skein. When thoroughly wet through in a hot bath the thread will soften until a skein may hardly bear its own weight. Accordingly, the dyeing is always done as quickly as possible, and generally at a lukewarm or only moderately high temperature. The skeins should be handled as little as possible in the dye bath, and when taken out to wring should be rinsed slightly to get rid of extra color, acid, etc., and then roughly dried, not by twisting on two sticks, as is customary with other materials, but by wrapping in cloth or blotting paper and then running the skeins backward and forward through the clothes wringer.

Tests for Artificial Silk.—All the varieties of artificial silk now on the market are made from some form of cellulose. Efforts have been made to take thick jellies made from gelatine or similar animal compounds and make threads from them, coagulating them later by treatment with formaldehyde or similar chemicals.

These experiments have, however, not as yet proved successful. Accordingly, the simplest test that will distinguish between a vegetable and an animal fiber will show whether a brilliant fiber or piece of goods contains natural silk or not. The simplest of the tests is, of course, to burn a little with a match or at a flame and see if you can distinguish the characteristic "burnt feather smell" of charring animal tissues. The chemist would probably make the same test more accurately by heating a wad of the material in the bottom of a small test tube and noticing whether ammonia was being evolved, and whether the distillate was alkaline in reaction. The ammonia and alkali resulting from the nitrogenous organic matter is a good indication of animal matter.

To distinguish between mercerized cotton and artificial silk, it is generally enough to soak the samples for a short time, say a quarter of an hour, in boiling water and test their strength. Mercerized cotton properly made would be just as strong afterward as before, while the artificial silk would be soft and weak, if it would not, indeed, break down completely. Besides this it must be remembered that the mercerized cotton, in spite of its luster, is made up of threads tightly spun together from a large number of short fibers, none of which are over two inches or so in length, while the artificial silks are made up like natural silk, of long, continuous fibers twisted together to form the yarn.

Dyeing of Artificial Silk.—In general these artificial silks are dyed much like cotton or mercerized cotton, with the Salt, Sulphur and Basic colors, according to the shades desired and the degree of fastness to light and washing needed. As before remarked, it is necessary to constantly keep in mind the delicate nature of the fiber when wet and hot and to avoid straining or stretching it while in that condition.

The Chardonnet silk has a special affinity for the Basic Colors, and unless specially fast shades are required are often dyed with them without any previous mordanting in a bath acidified with acetic acid.

This silk does not attract the Salt or the Sulphur colors as readily as the Elberfeld (Glanzstoff) or the Viscose silks, but can

be dyed very well with them if an extra amount of dyestuff is used to bring up the shade.

On the other hand, Glanzstoff and Viscose silk, without mordanting, can only be dyed light shades with the Basic Colors, but can be easily dyed with the Salt Colors (Diamine, Dianil, Janus, Benzo, etc.) and the Sulphur Colors.

The artificial silk, after dyeing, should be finished much like natural silk, by rinsing and then passing through a bath containing some olive oil, emulsified in a weak bath of soda ash. This increases the luster. They should also be dried at a fairly low temperature and while drying kept stretched out by hanging a wooden or glass rod in the loop of the hanging skein, or some similar device, care being taken to avoid strain great enough to pull apart the weakened fiber.

In conclusion, when carefully made and dyed these artificial silks furnish beautiful, brilliant, lustrous fibers, which can be used to great effect in many kinds of handicraft work. They can easily be procured with more luster than the very best natural silk, but even when dry are deficient in elasticity, and to some extent in strength, and when wet are very fragile. The price is kept at a rather high figure, as a rule from 25 to 50 cents a pound less than that of good natural silk. But every year the production is increasing, new factories are springing up in every country, and as there is no limit to the production excepting the demand, it is probable that in a year or two, thanks to competition, the price will be dropped very considerably and the whole silk business will be revolutionized. At present it is estimated that the production of the artificial silk is not far from one-fifth that of natural silk, and this fraction is getting larger every month.

Indeed, the rise of this particular industry may fairly be considered as one of the most interesting, most useful and most valuable inventions of the manufacturing chemist during the last quarter century.

In preparing this series of articles limited space has made it impossible to go more into practical details than I have done, but I shall be glad to answer any inquiries as to methods of working which may be addressed to me in the form of a personal letter sent in care of THE CRAFTSMAN.