The Pictorial Representation of Luster in Textiles

By H. VOM HOVE, KARLSRUHE, GER.

Luster in fabrics is due to the uniform reflection of a certain quantity of light by the surface of the material in question. Let us consider a smooth glass rod: It has a luster, the light reflection of its surface is regular. If we roughen this glass rod with flint paper the luster is decreased at once, and by rubbing still harder, the dull surface loses its luster entirely.

A scratch on a smooth glass surface presents an unevenness, so that it cannot reflect the light rays uniformly but reflects them in all directions diffusely.

Applying this observation to textiles, cotton and wool have a certain luster when we examine the individual fiber, but the luster decreases greatly when they are spun into yarn on account of the very uneven surface of the yarn produced by the combination of the individual fibers. The same thing occurs when we cut the lustrous silk or rayon fibers into small pieces and spin them into yarns, as in "Sase." Here the luster is diminished greatly by the increased diffusion of the surface. In burette silk, a very short stapled material spun from silk waste, the yarn shows hardly any luster at all. The number of these short lustrous fibers in any given cross-section of the yarn has to be increased materially in comparison to the number in a long stapled yarn such as schappe silk if the yarn is to possess a certain amount of strength. This greatly increases the number of small projecting ends of fibers in each centimeter of length of the yarn, which can either produce or destroy the luster of fabrics. (See below). For this reason cloth which is to be mercerized is first singed.

The mercerization of cotton under heavy tension is known to be for the purpose of removing the corkscrew twist from these fibers, producing a round structure like a glass rod from the flat ribbon and brightening the fiber itself. All of these effects increase the reflection of light from the outside as well as the interior of the fiber and thus increase the luster. Mercerization for the purpose of producing luster is possible only with long stapled fibers, since a short stapled material would not increase greatly in luster even if it could be mercerized under heavy tension, as is clearly shown by the burette yarn and fabrics made of it.

There are still other means of making fabrics lustrous. For instance, if one attempts to alter a hairy non-lustrous cotton cloth (barchent) by heating it to 100° for an hour at a 12 mm. vacuum over sulfuric acid, it carbonizes to be sure, but shows a beautiful silky luster.

The fabric still is strong enough to allow it to be wet out and dried several times repeatedly, but the fine silky luster decreases each time. Using a binocular microscope with a magnification of 60, it is seen that all the projecting fibers and fiber ends have vanished leaving only very short stumps, so that they do not destroy the luster by diffusing the light. The fibers themselves still have the same corkscrew shape as before and are not much more lustrous, except for the fact that the blackening of the fibers decreases the diffusion of light in the interior of the fiber.

A somewhat similar method of producing luster on dull fabrics consists of changing the position of all the fibers on the surface of cloth which diffuse the light, i.e., forming a plane surface by mechanical means, so that this smooth surface reflects the light evenly, just as the roughened glass rod can be made smooth and lustrous by subsequent polishing.

This transposition of the fiber ends is obtained in the textile industry by calendering. This method of changing the surface of a fabric, very original from a theoretical standpoint is shown below in microphotographs.

In producing luster in this manner the construction of the fabric, i.e. the regularity of the lines of the surface, plays an important part, and has been made use of in a practical way in the "Gauffrier" process. Naturally such a luster is affected by water, since the fibers which have been pressed down on the surface

of the cloth in the calendering operation and thus contributed to the increased reflecting surface are raised again by wetting and diffuse photographically under high magnification from some samples of cloth.

Fig. 1. shows a silk crepe de chine fabric

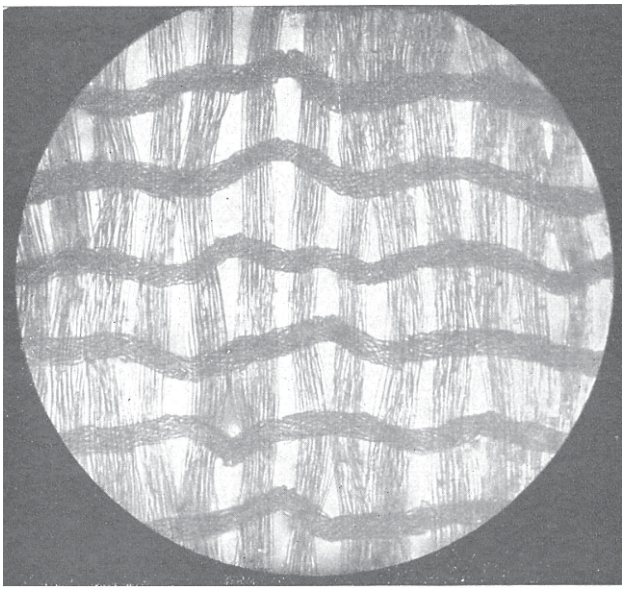

Figure 1. Silk crepe de chine (transparent view)

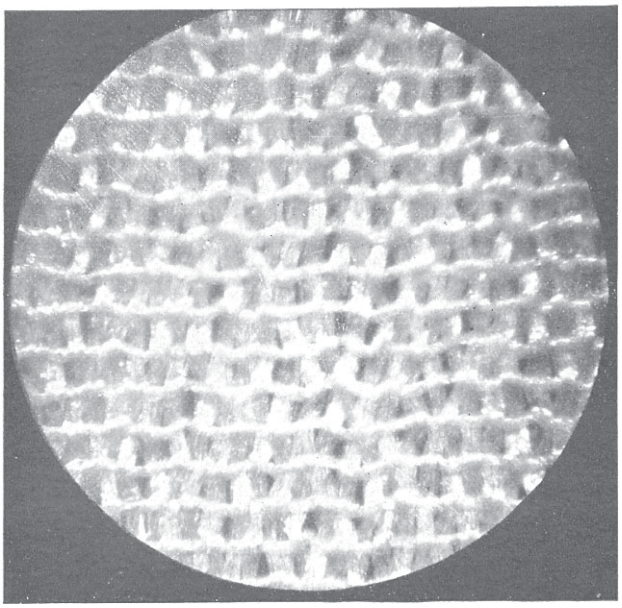

Figure 1-a. Silk crepe de chine (overhand view)

the light so that the cloth has a dull appearance. The "permanent finish" processes should eliminate this defect.

These minute changes in the surface of fabrics, which can be observed even to some extent with the naked eye, were recorded by transmitted light, magnified fifty times. The beautiful even structure is noticeable. The yarns with the smooth stretched fibers form the warp and the darker cross-hatched bars are the twisted filling yarns which show the crepe effect. Fig. 1a is a view of the same cloth by

reflected light. The even, honeycomb structure is interesting.

Fig. 2 is a view by transmitted light of a cotton cloth made of fine mercerized "Mako" yarn. The luster is very good although decidedly less than that of the silk fabric in Fig. 1. The reason is the greater irregularity of the individual yarns, from which the fibers project in all directions. Their crisscross position—not meaning the regular twist—, interferes greatly with the light reflection. Nevertheless this cloth shows very good uniformity considering the material of its construction is cotton. The individual fibers are quite long and promote luster. For instance there is one long fiber to be noted on the fourth yarn from the left, which extends from the upper part to the lower edge of the picture.

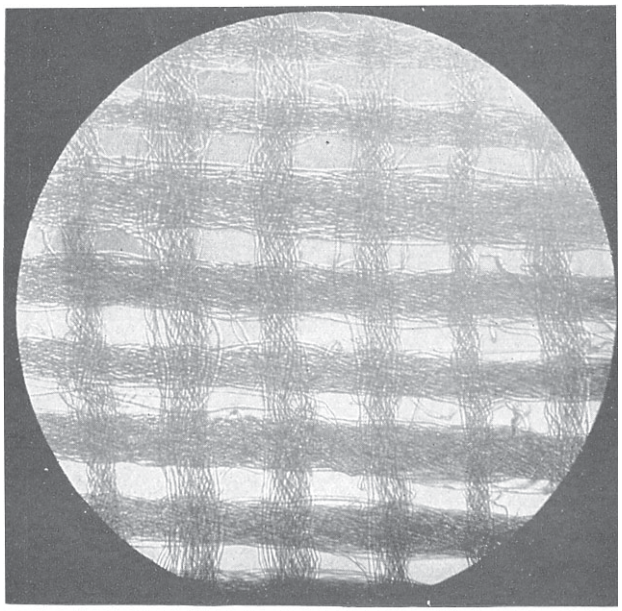

Figure 2. Mercerized cotton batiste (transparent view)

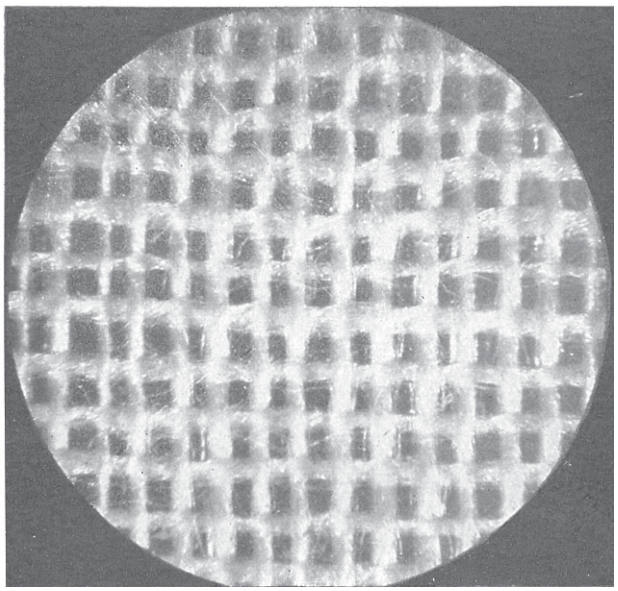

Figure 2-a. Mercerized cotton batiste (overhand view)

Fig 2a gives a fine view by reflected light of the same cloth under lower magnification in which the same appearances discussed under are twice as thick. The fibers are very blurry because they lie in different planes on account of the thickness of the cloth; the ends of

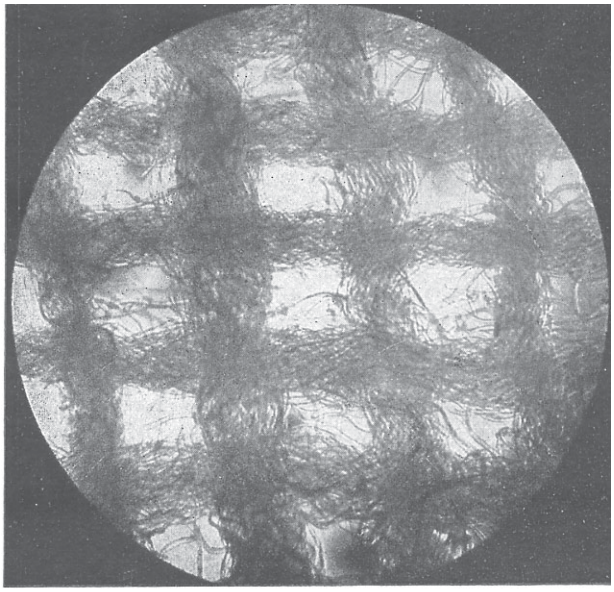

Figure 3. Mat cotton fabric (transparent view)

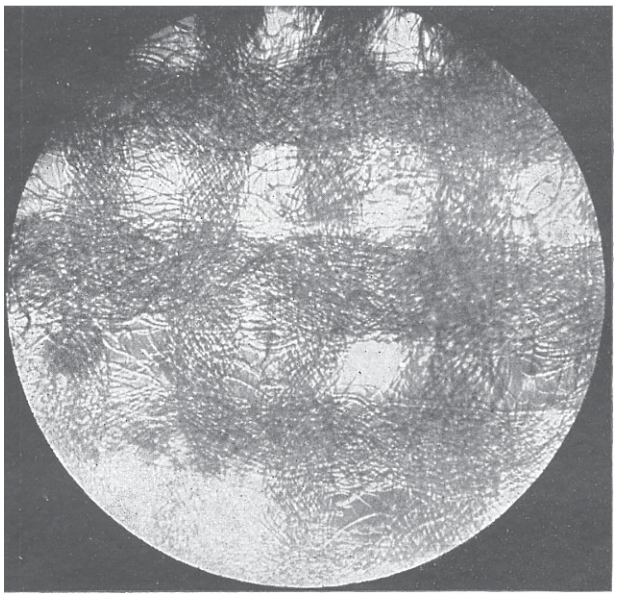

Figure 4. Mat cotton fabric, very highly calendered and polished (overhand view)

the transmitted light view can be clearly observed.

The third picture presents a rougher lusterless cotton fabric known as "reenforced." We see only four yarns in the space occupied by six yarns in the cotton batiste, since the yarns the fibers are especially far away from the yarns. These facts, and in addition the fibers being unmercerized, give the fabric a very dull appearance.

Fig. 4 shows the same cloth strongly calendered and polished.

One notices at once the greater clarity of this photograph, and also the smaller size of the light squares between the broadened yarns. Since all the fibers have been pressed flat by the friction and pressure of calendering they are all more or less in the same plane, consequently the picture is sharper and clearer. The fibers which were sticking out before are laid in the spaces between the yarns. The reflecting surface is so increased by this new factor that the cloth has a high luster similar to the mercerized batiste of Fig. 2. The corresponding views by reflected light (Figs. 3a and 4a) which have only half the magnification of the transmission pictures, Fig. 3 and 4 resp.,

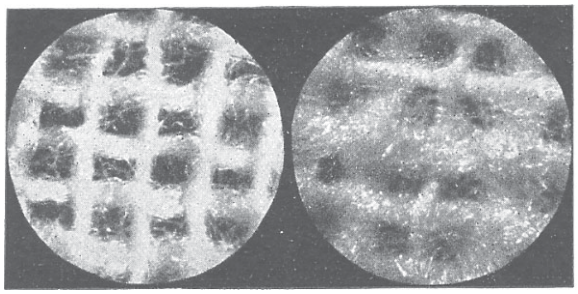

Figure 3-a Figure 4-a

do not show the condition so clearly, because the changes producing luster are small as stated before. It can be seen, however, that the individual yarns are considerably broader in Fig. 4a and that the dark empty spaces between the yarns are filled up with fibers and are smaller than in the untreated fabric.

Nature uses a still different method in the leaves and petals of plants, for instance in some varieties of begonias, to produce a luster like silk taffeta.

She has equipped the surface of these leaves with a cell layer having strong walls. These cells are held full of cellular fluid by the cell pressure (turgor) so that the cell walls are stretched tight and smooth. The light is reflected uniformly from these tiny flat surfaces. The dark parts of the leaves increase the luster. If we decrease the cell pressure by breaking a leaf and leaving it for some time exposed to the air, the luster decreases at once, because the outer skin of the cell (cuticle) forms small folds which cause the light to be diffused. When placed in water the plant again develops a normal cell pressure and simultaneously a luster. At the same time slight physical changes occur in the surface of the tissue.

The photographs were made with a metallographic projection apparatus, the samples of cloth being held between two metal rings, and stretched over a glass plate (Fig. 5). When

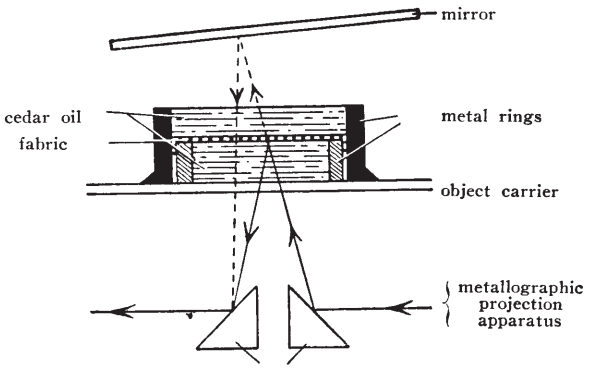

Figure 5
The rays of light reflected by the mirror produce sharp contrasts among the fibers of the cloth when viewed as transparents

taking the pictures by transmitted light there was a layer of oil above and below the cloth as a dispersing liquid and a mirror over the oil. Of various oils cedar oil was found to give the clearest pictures. The path of the light rays is shown in Fig. 5. The pictures by reflected light were taken without any oil or mirror.

Literature on the Luster of Fibrous Materials.

J. Bergmann, Handbook of Finishing 1929, pps. 233-34.

H. Fischer, Zeitschrift für Farbenindustrie 1907, 6th year, pps. 271 and 295.

N. Gaidukov, Zeitschrift für angewandte Chemie, 1908, p. 393.

A. Herzog, The microscopic investigation of silk and rayon, p. 71, (1924).

A. Herzog, Kunstseide, 1916, 6th year, pps. 153 and 163: On the luster of fibrous materials.

A. Klughardt, Zeitschrift für technische Physik, 1927, p. 109.

H. Schulz, Melliand Textilberichte, 1924, p. 25.