POLARIZATION EFFECTS SHOWN BY FILMS OF CERTAIN FUSED SALTS

By D. B. Deodhar and G. B. Deodhar

Abstract

Some experiments made by Talbot and Lord Rayleigh have been repeated and extended. A film was prepared by evaporating a solution to dryness on glass, then fusing the salt and letting it cool. In the case of potassium nitrate and potassium chlorate, when the film was placed under a microscope and between crossed nicols, Talbot and Rayleigh had observed irregularly distributed patches varying from dark to light, and variously colored. It is now found that silver nitrate and benzoic acid also show the effect. The intensity diminishes with time but the variations can still be observed after six months. A *film formed by evaporating a binary solution* of a mixture of any pair of the following: alum, boric acid, borax and citric acid, also showed the effect although films containing only one constituent were inactive. The effect is doubtless the result of mechanical strains developed on cooling the film, similar to those obtained when glass is chilled from above its softening point.

Introduction

SOME years ago the late Lord Rayleigh[1] had published a note upon a remarkable phenomenon of Newtonian colors seen by Talbot, when fused nitre was observed under crossed nicols by means of a polarizing microscope. Talbot found that the fused film appeared to be made up of crystalline plates of irregular shape, often fitted together like a tesselated pavement. If one plate was darkened by rotation of the nicol, others remained visible in varying degrees of brightness. On suitably increasing the quantity of the salt he could see the display of gorgeous colors. He also observed that the whole appearance rapidly changed in a surprising manner, and that the whole color phenomenon ceased at the end of about a quarter of an hour, the field becoming quite dark. The late Lord Rayleigh repeated this experiment with nitre and extended his observations upon potassium chlorate in practically the same way as Talbot had done, and found that the chlorate colors were less beautiful than those of the nitre. He also found that the potassium chlorate colors lasted for a longer time than nitre colors. Reinders,[2] Brauns,[3] Lehmann[4]

[1] Rayleigh, Collected papers, Vol. 6
[2] Reinders, Zeits. phys. Chem. 1912
[3] Groth, Physikalische Krystallographie
[4] Lehmann, Molekular Physik

and Tutton[5] have also touched upon these color phenomena. In the present work the observations of Talbot and Rayleigh have been repeated and extended.

Observations

(a) A few drops of *potassium nitrate* solution were laid upon a clean piece of glass, and were slowly evaporated to dryness. Then the dry substance was melted, the glass piece was removed and allowed to cool for a little while, and after some four or five minutes it was placed on the stage of a microscope having a nicol polarizer below and a nicol analyzer within the body of the instrument, set for extinction. Observations were made with sunlight and the whole field presented the appearance of a tesselated pavement of irregular boundary lines as described by Talbot. Different patches, some dark, some bright, some of varying shades of brightness and darkness, and some exhibiting brilliant Newtonian tints of varying intensity, were irregularly distributed throughout the field. On rotating the polarizing nicol through 90°, it was observed that the dark patches became bright, while the color tints changed to complementary ones. As time increased, the color effect appeared to decrease; but its rate of decrease was found to be slower and slower as time went on. After the lapse of about an hour's duration, changes in the intensity of the colors could not be detected.

(b) *Potassium chlorate* was treated in the same manner and its general behaviour was found to be the same as that of potash nitrate. The only difference detected was that the intensity of color was far stronger than that with nitre, contrary to the result obtained by Rayleigh. The rate of decrease in the color intensity with increase in time was found to be less than in the case of nitre.

(c) *Silver nitrate* was tried and found to behave as above.

(d) *Benzoic acid* showed very gorgeous colors under crossed nicols, which changed very slowly with time. It was further noted that if the heat given is just sufficient to melt the acid, the colors are very vivid; but if the heating is pushed a little too far, the color effect becomes quite dull.

(e) Another peculiarity which is observed during these experiments is, that if while observing through the eyepiece, under crossed nicols, a light scratch is made upon the fused substance on the glass piece by means of a pin point, at once colors begin to jump out of the point of disturbance in all directions, the small portion round the scratch giving an appearance of a peacock feather. The path of the pin point could be followed by the

[5] Tutton, Text book on crystallography

beautiful radiant color streaks. This effect is most striking a few minutes after melting; and when the substance becomes cold, the pin point cannot scratch and consequently the radiant color streaks cannot be observed.

(f) In order to find out the effect of time on our substances, they were carefully preserved. Unlike Talbot and Rayleigh, we found that all our preparations showed colors even at the end of six months. Of course, the intensity was not the same as that observed when the specimens were freshly prepared, but the effect was still clearly evident. This shows that the rate of diminution of intensity becomes extremely slow as time advances. These specimens are still being watched.

(g) A few drops of a solution of ordinary alum in water on clean glass were slowly evaporated to dryness, and the behaviour of the substance was observed without fusing it; but nothing could be seen under crossed nicols. Citric acid, boric acid and borax also showed the same negative behavior. However in the case of a mixture of boric acid and alum, color effects were observed, which showed the usual complementary relations on rotating the polarizing nicol. A mixture of citric acid and boric acid and of borax and citric acid also showed the same complementary color relations.

Discussion

Our observations of color effects indicate the existence of anisotropic molecular aggregates with their optic axes oriented at random; and it appears that the double refraction property may be due to the intermolecular strains and stresses developed on account of the setting of two different types of molecules in mixtures; similarly as a result of the cooling of the fused substances, unequal stresses and strains would be introduced.

Physics Department,
Lucknow University, India,
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