Summary.

A new and rapid photographic method for the establishment of self-excitation was elaborated which can also be applied to objective measurements. Self-excitation was shown in the case of rigid gelatine solution of acridine orange.

The measurements were made at the Physical Institute of the University of Szeged.

Acknowledgement.

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On the Structure of Gelatine

By L. Szalay and J. Grasselly

Introduction.

Many investigators have dealt with the structure of gelatine approaching the problem from the chemical and physical point of view. According to earlier investigations carried out with *X*-rays no crystal interference could be observed. Two diffuse fringes were found, hence it was established that gelatine is a mixture of two amorphous substances (1). Further roentgenographic examination showed the *X*-ray diagram of gelatine to have a typically broad fringe, surrounded by another distinct one characteristic of crystal interference. A second diffuse ring can also be observed (2). On stretching the gelatine the diffuse fringe characterising the amorphous state changes and resembles the distinct interference ring.

It was assumed that in a normal state gelatine is probably a crystalline substance possessing a very disordered structure having, however, periodicity in one direction. On the other hand, it was also suggested that the distinct fringe is caused by parallel elements but not by a lattice structure.

The occurence of a fringe characterising crystalline interference was shown by different investigations (3). Several authors have stated that gelatine has a crystalline structure, or that at least besides the amorphous modification it contains also undoubtedly crystalline ones, consequently gelatinization means crystallization.

However, on the base of the roentgenodiagram some authors come to the conclusion that gelatine consists of highly polymerized components, probably of amino acid chains which interlace in a sponge like manner. In the holes of the sponge a less amorphous form can be found (5).

On the base of later investigations the conception of gelatine chains having under certain circumstances an almost perfect lattice structure arrangement became preponderant (6). Several authors also made an attempt to determine on the base of the diagrams the size of the elementary cell (7, 8, 9). In this relation the recorded data diverge considerably. According to one author the crystal lattice of collagen is monoclinic and both the collagen and gelatine are roentgenographically identical (9).

According to Clark there is no satisfactory interpretation for the crystal structure, nevertheless, concerning a collagen compound, the orthorhombic form of its crystal lattice could be established (8). The transition point of gelatine was found to vary, this fact was interpreted by the assumption of the crystals varying in size (10), which probably is also the cause of the divergence of the data recorded by different authors as to the size of the unit cell.

Results.

At the experiments dealing with fluorescence and phosphorescence carried on at our institute the dyes were dissolved in a gelatineous solution. After solidification of the solution the behaviour of the dry gelatineous dyestuff solution was investigated. Naturally pure gelatine was also examined from different points of view (11).

On preparing the preparation the gelatine is dissolved in hot water and the solution is poured on to a mercury surface, from which it can be easily removed after solidification in the form of a thin plate (12). The plates used for the investigations were 0.1—0.3 mm. thick. The ash content of the gelatine was 2.10 per cent.

On examining the preexcitation effect there seemed to be a possibility to explain it by the orientation of molecules (13). The researches relating to the preexcitation effect revealed that the intensity of the emission excited by polarised light depends on the direction of the polarization of the preexciting light. In connection with these investigations it was found particularly necessary to examine the optical behaviour of gelatine concerning polarized light.

Above all it seemed desirable to establish the well known anisotropic character of the gelatine layer. The plate was examined under a polarisation microscope between crossed nicols. As expected on each revolving of the object-table darkening, resp. lightening could be observed four times. The extinction was, however, not complete.

On examining the preparations under the polarisation microscope between crossed nicols an interesting phenomenon could be observed. Not quite perfect plates exhibited at several points bubbles which were also visible to the naked eye. On examining them between parallel nicols they did not exhibit any particular characteristics, however, on investigating them between crossed nicols, an interference figure appeared resembling that induced by biaxial crystals under conoscope. Under the orthoscope — on examining with parallel beams of light — no interference figure could be observed. Investigating the parts of the plate not demonstrating bubbles the phenomenon mentioned above could not be seen. Under the orthoscope on the other hand, the points containing bubbles showed the interference figure. This phenomenon could only be explained by assuming the bubbles to behave as a converging optical lense thus modifying the orthoscope into a conoscope. Therefore if our assumption was correct the points not revealing bubbles had also to show the interference figure under the conoscope.

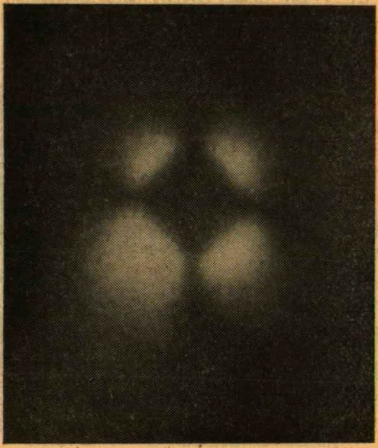

Fig. 1.

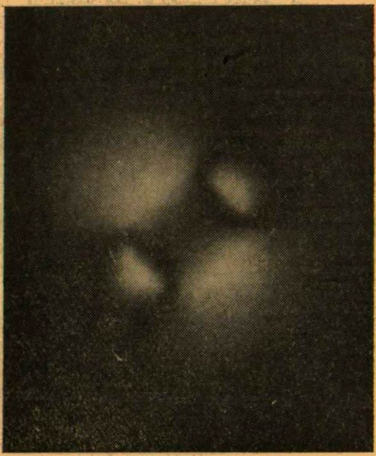

Fig. 2.

The investigations proved the correctness of this supposition. Under the conoscope the interference figure exhibited on photos No 1.2 could be obtained from every point of the plate. If the axial plane, i. e. the plane including the two optical axes lies parallel to the direction of vibration of the polariser, Fig. 1 shows the interference figure. If, however, these two directions are inclined at an angle of 45° the figure is like that shown on Fig. 2.

It can therefore be stated that rigid gelatine behaves like a biaxial crystal, or that at least of its two forms — amorphous and crystalline — the latter has a biaxial crystal structure.

Hitherto the roentgenograms did not offer a decisive solution of this problem.

According to one author the roentgenodiagram of collagen indicates that the crystal system is monoclinic and according to another it is rhombic, they also assert the roentgenographic identity of gelatine and collagen. The researches mentioned above refer to gelatine. Our investigations did not either yield an accurate definition of the crystal system. However, it could undoubtedly be proved — in accordance with the results of other investigators — that the crystal modification of gelatine behaves like a biaxial crystal.

As regards the optical character of the crystal employing a 1.0. gypsum plate the substraction was found to be parallel to the direction of the smallest elasticity of the gypsum plate, consequantly the gelatine crystals are of negative optical character. Fig. 2. indicates that the optical axes are close to each other, therefore the bisector of the acute angle is probably perpendicular to the plane of the plate.

Some investigations were also carried out concerning the modifications of the structure during solidification. The dilute solution did not exhibit anisotropy. The same refers to the state of the solution which has not yet undergone solidification, which fact undoubtedly supports the establishments of Derksen and Katz as well as those of Sokolov (4). Namely according to Sokolov a 10 per cent gelatine gel exhibits a very distinct crystal interference fringe, a 10 per cent gelatine sol a less distinct one, whereas the highly dilute 1 per cent sol showes only an amorphous fringe. Recent investigations prove that the interference fringes obtained on gelation can be explained by an orientation process and not by crystallization which was also established by Sokolov. On solidification, however, a definite crystal structure is formed, an anisotropy of high degree can be observed, and the interference figure appears.

As the characteristic interference figures can be obtained on any section of the plate it is evident that its behaviour is uniform and that during solidification a regular arrangement takes place (5).

Further investigations are in progress.

Summary.

The structure of solid, dry, 0.1—0.3 mm. thick gelatine layers was investigated. The most important results are as follows:

1. The layers possess only in rigid state a crystal structure. After solidification the whole plate has a uniformly anisotropic character.

2. The crystalline form of gelatine undoubtedly behaves like a biaxial crystal, consequently it belongs to either the rhombic, the monoclinic or the triclinic sytem. The crystal has an optically negative character.

3. The axial plane of the crystal is perpendicular to the plane of the gelatine layer.

4. The direction of the greatest elasticity is perpendicular to the plane of the gelatine layer.

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