Secondary Emission and Electron Diffraction on the Glass Surface

The optical surfaces of some optical glasses especially those containing a high percentage of barium and lead often show stain or interference hues due to very thin films of compounds formed on the glass surface as a result of attack by moisture or by various vapors contained in the atmosphere.

Because of the minute quantities involved, these compounds can hardly be analyzed chemically or by x-rays. We have succeeded, however, in obtaining electron diffraction patterns of such surfaces.

The difficulty with obtaining diffraction photographs from the surface of a good insulator results from the charging up of this surface. The method here used has obviated that difficulty. Measurements[1] show that the secondary emission of electrons from a glass surface increases from 1 to a maximum of about 2 as the velocity of the primary electron beam increases to a few hundred volts. As the velocity is further increased the emission factor decreases and becomes smaller than 1.

In the present experiments a beam of high velocity electrons (40–50 kv) which is to be diffracted was projected on the surface. At the same time a beam of low velocity electrons (~300v) was projected on the same surface in a direction perpendicular to the high velocity beam and at about 30° to the surface normal. By adjusting the intensity of this beam the resulting secondary emission factor for the two beams could be made zero and as a consequence the surface would remain electrically neutral.

With this technique it was found that a freshly polished surface of glass shows amorphous halos as indicated in Fig. 1A at $\sin \frac{1}{2}\theta/\lambda = 0.13$, 0.20, 0.37. These values differ somewhat from previous results of transmission experiments on an amorphous silica film.[2] This suggests that the polished layer has a structure different from that of the base glass.[3]

Surfaces which have become tarnished give various diffraction rings which differ according to atmospheric conditions, time, and kind of glass. Polished surfaces of optical glass containing a high percentage of BaO (e.g., SK_4, $BaLF_4$) and a high percentage of PbO (e.g., SF_2, SF_5) after being kept about two months in an atmosphere rich in humid SO_2 gas at room temperature show interference colors produced by a film the thickness of which is of the order of the wave-length of light. Investigation shows that this film is $BaSO_4$ in the case of barium glass (Fig. 1B) and that it is a mixture of PbS and $PbSO_4$ in the case of the lead glass (Fig. 1C). A detailed account will be reported in a Japanese journal.

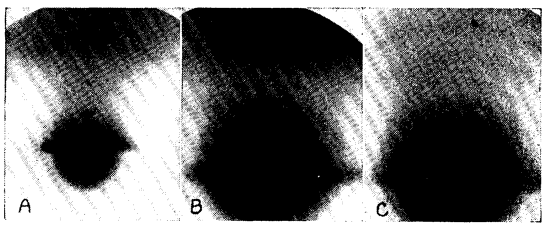

FIG. 1. A, Amorphous diffraction halos from a polished glass surface. B, Diffraction rings from the surface of a tarnished barium optical glass ($BaLF_4$). C, Diffraction rings from a tarnished lead optical glass (SF_2).

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[1] H. Salow, Zeits. f. Physik **21**, 8 (1940).
[2] L. R. Maxwell and V. M. Mosley, Phys. Rev. **47**, 331 (1935); H. Kamogawa, *ibid.* **54**, 91 (1938).
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Fission Products of Uranium by Fast Neutrons

Under the above title we reported[1] the results of investigations on silver, cadmium and indium isotopes obtained from uranium by bombardment of fast neutrons. In continuing our experiments we found that palladium isotopes are also produced by fission, and one of them is the mother substance of the 3.5-hour silver isotope, Ag^{112}, which was mentioned in the above note. The experimental procedure was as follows.

The palladium fraction, which was separated as dimethylglyoxime salt from an irradiated sample and was carefully freed from the known fission products of uranium such as silver, antimony, tellurium, iodine, molybdenum, barium, lanthanum, cadmium, indium, etc., as well as from uranium itself, was examined for its activity. The decay curve, which was obtained from samples of long exposure, shows two periods, the longer one being 17 hours and the shorter one 26 minutes.

Under the supposition that the 17-hour palladium probably forms the mother substance of the 3.5-hour silver isotope mentioned above, we tried the search for this daughter product in the following manner. After 15 hours from the time of separation, the palladium compound was ignited, the residue was fused with sodium bisulphate and the melt was dissolved in water. From this solution, after adding silver nitrate as carrier, silver was precipitated as silver chloride. From the filtrate, palladium was precipitated with hydrogen sulphide. Both precipitates were then tested for the activity. The decay curve of the silver chloride showed a half-value period of 3.5 hours, which was ascribed to Ag^{112} as mentioned in the above note in *Nature*. A similar method was tried to see if any silver isotope is produced from the 26-min. palladium but the result was negative. It is thus clear that the 3.5-hour silver grows from the 17-hour palladium, which therefore is identified with Pd^{112}. On the other hand, the identification of mass number of the 26-min. palladium is not yet certain.

The results of our investigations on the fission products of uranium so far obtained by fast neutrons are summarized in Table I.

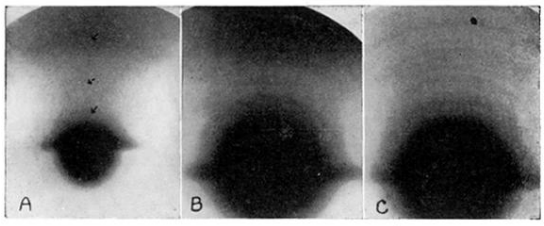

FIG. 1. A, Amorphous diffraction halos from a polished glass surface. B, Diffraction rings from the surface of a tarnished barium optical glass ($BaLF_4$). C, Diffraction rings from a tarnished lead optical glass (SF_2).