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Paramagnetic Resonance of Hydrogen Fused Silica

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Résumé.

La silice fondue purifiée ne montre ni absorption optique ni résonance paramagnétique après irradiation aux rayons X à la température ambiante. Par contre, l'irradiation à la température de l'azote liquide produit deux bandes d'absorption dans l'ultraviolet et un spectre de résonance paramagnétique dont l'intensité croît avec le pourcentage en eau. Les mesures de résonance paramagnétique suggèrent que les centres colorés produisant ces phénomènes sont des atomes d'hydrogène. Ils disparaissent en quelques minutes à une température de 10-20° C au-dessus de celle de l'azote liquide.

Purified fused silica was irradiated with 150 kV X-rays. Irradiation at room temperature resulted neither in coloration, nor in paramagnetic resonance. After irradiation doses of a few million röntgen at liquid nitrogen temperature, however, both coloration in the u.v. part of the spectrum and paramagnetic resonance were found. The latter was measured at 3 cm wave length. The spectrum consisted of two lines of width 1 gauss. Their intensity increases with increasing water content of the samples. The lines are attributed to proton hyperfine splitting. This interpretation was checked by replacing part of the protons by deuterium. From the position of the lines the following parameters were determined: g — factor $= 2.003 \pm 0.001$ and hyperfine parameter $A = 1.428$ MHz. These values, together with the isotropy of the lines, are explained by the assumption that one has to do with hydrogen atoms, trapped in the fused silica network. Similar centres have been found by Livingston a.o. [1] in irradiated H ClO_4, H_2SO_4 and H_3PO_4. Just as in these acids, the centres in fused silica disappear in less than a few hours at temperatures, higher than about 90° K. It is thought that this occurs because the hydrogen atoms start moving and recombination takes place. The process by which

the centres disappear is probably a bimolecular one and its activation energy is 0.2-0.3 eV.

Ordinary, non-purified fused silica is coloured by X-rays even at room temperature, but the amount of coloration depends on its water content; more water means less coloration [2]. The formation and mobility properties of the hydrogen atoms described here give perhaps an explanation for this. It is supposed that the hydrogen atoms act as carriers for the transport of electrons that are thus able to combine with other centres.

1. Livingston, R., H. Zeldes and E. H. Taylor, *Disc. Faraday Soc.*, *19*, 166-173, (1955).
2. van Wieringen, J. S. and A. Kats, *Philips Res. Rep.*, *12*, 432-454 (1957).