

seem to be possible in the solid state. The visible absorption maxima for 1-aminoanthraquinone are 4450 Å. (hexane⁴) and 4900 Å. (solid state), for 2-aminoanthraquinone 4300 Å. (hexane⁴) and 4550 Å. (solid state), and for 1:5-diaminoanthraquinone 4820 Å. (dioxane⁵) and 5070 Å. (solid state), so that there is a strong bathochromic shift in the solid state similar to that which occurs with indigo. The formation of intermolecular complexes may well be the reason for the marked improvement in the photochemical stability when the aminoanthraquinone compounds are present in the solid phase. It is worth noting, however, that when the complex occurs between the dye molecule and nylon substrate the light stability is poor. The aminoanthraquinone compounds do in fact show a marked bathochromatic shift on nylon similar to that given by the dye in the solid state, but presumably the unsymmetrical character of the complex formed is responsible for the poor photochemical stability.

G. S. EGERTON
A. G. ROACH

Department of Textile Chemistry,
Faculty of Technology,
University of Manchester.

¹ Egerton, G. S., and Roach, A. G., *Nature*, **179**, 491 (1957).

² Weinstein, J., and Wyman, G. M., *J. Amer. Chem. Soc.*, **78**, 2387 (1956).

³ Sheppard, S. E., and Newsome, P. T., *J. Amer. Chem. Soc.*, **64**, 2937 (1942).

⁴ Lauer, K., and Horio, M., *J. Prakt. Chem.*, **145**, 273 (1936).

⁵ Hartmann, H., and Lorenz, E., *Z. Naturforsch.*, **72**, 360 (1952).

Decrease in Fluorescence Intensity of a Solution of Fresh Cigarette Smoke Products on Exposure to Light

ATTENTION has been directed by Schmähl and Schneider¹ and Druckrey and Schmähl² to the decrease in intensity of fluorescence which occurs when a benzene solution of fresh cigarette smoke products is exposed to light. This decrease in fluorescence indicates one obvious difference between the smoke, which will contain unchanged products when inhaled by the smoker, and any solution of the smoke products which has been exposed to light and which is then used for chemical or biological tests.

Schmähl and Schneider¹ found that the rate of decrease of intensity of fluorescence is dependent on the intensity of the light, and that ultra-violet light could cause decrease below the end-value which could be reached with daylight. It was concluded that more than one 'labile' component existed. The chemical nature of the 'labile' components was not known; but they were not thought to be aromatic hydrocarbons or alkaloids and were non-polar.

The present findings are that the 'labile' fluorescent components are products of heating the tobacco and paper, since no decrease occurs in a benzene extract of unsmoked tobacco. On heating tobacco to temperatures of 200–300° C., distillates are obtained (boiling points below 200° C.). The fluorescence intensity of a benzene solution of these distillates decreases at a similar rate to that of tobacco smoke products when exposed to light.

This phenomenon is in fact not unique to tobacco, but appears to be common to many vegetable products heated to these temperatures. 'Cigarettes' were

manufactured containing sawdust, cotton-wool, cellulose powder and the dried leaves of three common weeds. When these were smoked mechanically in the same way as ordinary cigarettes the fluorescence intensity of solutions of the smoke products in benzene decreased on exposure to light. Similarly, decrease occurred with cigarettes the tobacco in which had been exhaustively extracted with concentrated acid and alkali and organic solvents. The rates of decrease were similar to that of tobacco smoke products, but the percentage of the total fluorescent material which was labile varied for the various substances. However, tobacco is the only vegetable product commonly smoked and inhaled into the lungs in this manner, and therefore this decrease in fluorescence might still be significant.

Greene³ stated that the formation of free radicals might be expected when organic material is subjected to treatment similar to that of tobacco in cigarette smoking. Photochemical reaction such as described above suggests also a free-radical mechanism or intermediate. It is possible that some of the tars or resins in cigarette smoke products might be products of free-radical initiated polymerization; however, anhydrous aluminium chloride, which is a catalyst for ionic polymerization, proved a much more effective catalyst for the precipitation of resins from solutions of cigarette smoke products than the free-radical polymerization catalysts which were tested. Many authors have discussed the carcinogenicity of free radicals and of substances which can readily form radicals *in vivo*. It has been suggested that radicals might be detected in cigarette smoke products (Lyons, M. J., unpublished results). It is possible that the paramagnetic resonance methods of Commoner *et al.*⁴ for detection of free radicals, in biological matter and in coal tar, in the presence of much diamagnetic material, might be applicable to cigarette smoke products.

I am indebted to Dr. P. R. Peacock for helpful suggestions and to the Medical Research Council for a grant.

HILDA JOHNSTON

Cancer Research Department,
Royal Beatson Memorial Hospital,
Hill Street, Glasgow, C.3.
July 24.

¹ Schmähl, D., and Schneider, H., *Arzneimittel-Forsch.*, **5**, 348 (1955).

² Druckrey, H., and Schmähl, D., *Science*, **122**, 421 (1955).

³ Greene, C. R., *Science*, **123**, 227 (1956).

⁴ Commoner, B., Townsend, J., and Pake, G. E., *Nature*, **174**, 689 (1954).

Oxygen as a Donor Element in Germanium

THERE have been a number of studies of the germanium-oxygen system from the point of view of compound formation, thermodynamics and crystal structure. Some workers have studied the effects of oxide films on the surface properties of germanium, with particular reference to conduction and rectification. However, little seems to have been published on the behaviour of oxygen as a significant doping impurity in bulk germanium. Clarke¹ observed, during experiments on the effect of oxygen on surface conduction, that after repeated exposure to oxygen, followed by heating in a high vacuum, a high resistivity germanium sample acquired a permanent larger