

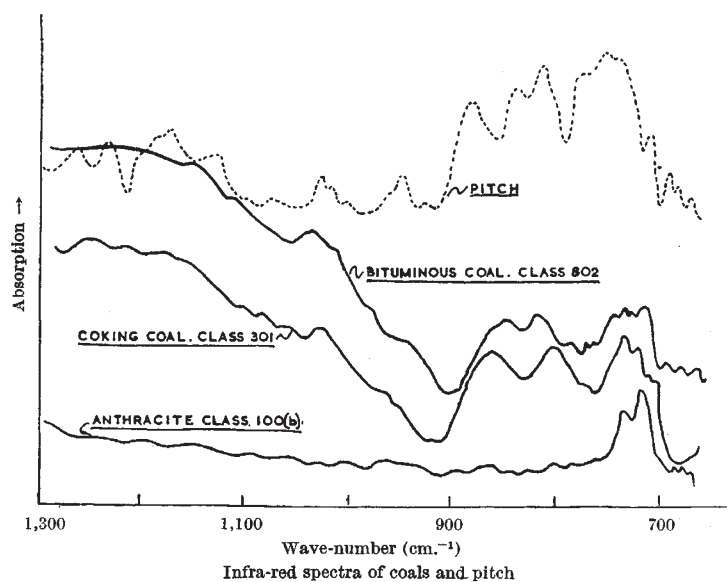
LETTERS TO THE EDITORS

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Infra-Red Spectra of Coals

Cannon and Sutherland have reported attempts to obtain infra-red absorption spectra of coals, first by examining thin slices of coal¹ and, secondly, by dispersing the finely ground coal in 'Nujol' (liquid paraffin)². Using the latter technique, they found it was essential to grind the coal to a particle-size of less than one micron before successful spectra could be obtained. Their examination was limited to the frequency-region 1,000–10,000 cm.⁻¹.

We have found that thin slices of coal and dry grinding of coal are both unsatisfactory. Satisfactory spectra have been obtained by the technique of grinding 1 gm. of coal together with 4 ml. of 'Nujol' for 18 hr. in a power-driven agate pestle and mortar. This suspension, in which 80 per cent of the coal particles were less than 1 micron in size, was used for preparing a cell with a layer thickness of 0.05 mm. Energy transmission was low, due to scattering of the incident radiation by reflexion from the particle surfaces, so that large slit-widths were necessary. To compensate for this scattering, backgrounds were prepared using a suspension of spectroscopic carbon in 'Nujol', prepared as for coal.



The infra-red absorption spectra (see illustration) of three coals (all of ash content less than 1 per cent) and of a low melting point pitch were obtained, over the frequency-range 750–1,300 cm.⁻¹, using a Grubb Parsons single-beam spectrometer. The pitch was melted on a heated rock-salt window to give a uniformly thick film.

The anthracite gives a spectrum differing considerably from those of the other two coals. It is interesting to note that organic groupings which occur in pitch also occur in coal.

No attempt has been made to assign organic groups to the absorption peaks recorded. An extensive

programme is in progress for the further elucidation of these spectra.

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¹ Cannon and Sutherland, *Trans. Farad. Soc.*, **41**, 280 (1945).

² Cannon and Sutherland, *Nature*, **156**, 240 (1945).

Nature of the Solution obtained by Pyridine Extraction of Coal

In a recent communication on the internal surface of coal¹, Dryden has directed attention to the interesting agreement between (a) the minimum particle-size observed by Nagelschmidt and Cartwright² in electron micrographs of films deposited from dilute ethylenediamine extracts from coal, (b) particle-sizes observed in the ultramicroscopic examination of similar extracts³, and (c) the order of particle-size concerned in the model of colloidal structure of coal suggested by Bangham *et al.*⁴.

The solutions obtained by the pyridine extraction of coal are commonly believed to be, like the ethylenediamine extracts, essentially colloidal dispersions. Nevertheless, the average molecular weights of the substances present in such solutions are only of the order of 500–1,400, and are inconsistent with their supposed colloidal nature⁵.

We have found that electron micrographs of the films formed by the evaporation of diluted pyridine extracts were almost identical in appearance with those described by Nagelschmidt and Cartwright. Examination of the particles by electron diffraction gave diffuse patterns only, resembling those for colloidion; and we had therefore interpreted our electron micrographs as being merely an extension to smaller dimensions of similar but grosser aggregation phenomena observable by optical microscopy.

We have now further examined our pyridine extract solutions. Samples of the diluted pyridine solution of a coal extract ($\beta + \gamma$ fraction) and of its chloroform-soluble components (γ fraction) were spread on a glass slide and the solvent eliminated by rapid heating to 180–200° C. in a stream of nitrogen. The specimens were then kept under a vacuum of 10⁻² cm. of mercury for about one hour. The deposits thus formed were collected on colloidion, or 'Formvar', by stripping off a film cast over the deposit. The structure previously observed with the deposits disappeared as a result of this treatment. Typical electron micrographs are shown in Figs. 1, 2 and 3. The cracked portions of the films were chosen to illustrate the varnish-like appearance of the deposit. Fig. 4 shows an intermediate stage in the deposition of the material, illustrating the melting of the aggregates observed in earlier photographs. There was no evidence of the presence in the material of discrete particles.

It would have been interesting if Nagelschmidt and Cartwright had made some comment on the behaviour