tion, and may or may not represent a coccolithophore. Type *d* (Fig. 2, right) shows longitudinally oriented blades of calcite, and presumably represents type *c* in longitudinal section.

The sections of coccoliths which appear on our electron photomicrographs are not directly comparable to the surface views obtained from free specimens. This is likely to be a taxonomic obstacle. Nevertheless, the structures seen in these sections are elaborate and distinctive, and the method clearly affords a means of extending research on coccolithophorids into the consolidated limestone facies. Furthermore, it furnishes an approach to the study of fine-grained limestone fabrics as a whole.

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Large Electron Pulses in Hydrocarbons

Abstract. *When gamma rays pass through purified, degassed, liquid hydrocarbons held in an electric field, large current pulses are observed, indicating electron multiplication. This seems to indicate that free electrons are stable in these liquids and that their mean free paths may be much greater than had been thought.*

We have observed large electric pulses in diodes filled with liquid hydrocarbons, under static voltages of 600 to 3000 and fields of 750 to 7500 v/cm, when subjected to Co^{60} gamma-irradiation from a 0.3 mc source at 8 rad/hr. The pulses were observed on an oscilloscope; their length was of the order of 3×10^{-5} second. The pulse amplitude varied among pulses at any applied potential; the maximum pulse amplitude increased with applied potential. At 3000 v, the largest observed pulses registered as a 20-v potential drop across the 10^6-ohm oscilloscope resistor, indicating a total charge transfer of more than 10^{-10} coulombs. This is much more than the charge separation of approximately 10^{-14} coulombs (maximum) produced in the electron tracks resulting from the passage of a single Co^{60} gamma-ray through the liquid. The number of pulses is less (by a factor of about 10^3) than the calculated number of gamma-rays absorbed in the liquid.

These pulses are larger by a factor of 10^5 than those observed by Blanc, Mathieu, and Boyer (*1*) at much higher fields (60,000 v/cm).

The apparatus consisted of two parallel disc electrodes immersed in the hydrocarbon in an all-glass cell. Pumping reduced the cell pressure to the vapor pressure of the hydrocarbon. The circuit included only the cell, a 3kv power supply (direct current), and the oscilloscope. The source of gamma-irradiation was held outside the cell, either on the central plane or on the axis. The electrodes were not protected from the radiation. No variation with source position was observed. The materials were: (i) *n*-octacosane (Eastman), purified by more than 100 passages in a two-coil Fisher zone refiner; (ii) commercial *n*-octacosane, conditioned by several cycles of heating to 150°C under pumping; and (iii) *n*-hexane, purified by passage through an Aerograph A90P gas-liquid partition chromatograph. Of these, material i gave the largest pulses. Total radiation doses delivered to any sample never exceeded 100 rad, so that radiolysis may be neglected.

Static conductivity of material (i) at 65°C was 5.5×10^{-14} $(\text{ohm-cm})^{-1}$ at applied fields of 1250 to 1875 v/cm in the absence of radiation. Below the value of the pulse threshold, gamma-irradiation at 8 rad/hr increased the conductivity by less than 5 percent. Above the threshold, the pulses prevented meaningful resistivity measurements.

In order to guard against spurious effects, several cells of two designs were used. Electrodes were similar (Al) or dissimilar (Pt gauze and Al), horizontal or vertical, and of different size and spacing. In one experiment, all metal parts were immersed in the liquid to eliminate gas-phase electron multiplication. In the several experiments materials i and ii were generally held at 61° to 90°C and material iii at −78°C. The large pulses were seen in all these cases.

The observed amplification appears to be due to cascading. This implies that most of the charge carriers (presumably electrons) attain kinetic energies which allow them to create new electron-hole pairs. To observe this phenomenon at fields as low as 750 v/cm, it is necessary to postulate that electrons are not trapped as a rule, that their mobilities are high (> 10 cm^2 v^{-1} sec^{-1}), and that they lose only a small fraction of their energy at each collision even when their kinetic energy is substantial (> 1 ev). This contrasts sharply with the behavior of electrons in less pure hydrocarbon liquids (*2*) which attach to molecules, giving ions which have mobilities of about 10^{-3} cm^2 v^{-1} sec^{-1} and do not rise above thermal energies.

Preliminary and inconclusive electron mobility measurements have indicated mobility values of 20 to 200 cm^2 v^{-1} sec^{-1}, in agreement with this explanation. We should expect that, in a material free from electron-trapping sites (trap-free material), electron mobilities could approach the values of 900 to 3900 cm^2 v^{-1} sec^{-1} observed in diamond (*3*).

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