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To cite this version:


HAL Id: jpa-00222363
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Submitted on 1 Jan 1982

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THE DEVELOPMENT AND USE OF NUCLEAR EMULSIONS IN ENGLAND IN THE YEARS 1945-50 (*)

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1. Introduction

I would like to add a little to the part of Professor Rossi's lecture concerned with the development and use of nuclear emulsions in England in the years 1945 - 50. Much had been achieved before 1945, especially by Powell and his collaborators, but the emulsions then available were severely limited by their lack of sensitivity.

2. Emulsion Development 1945-6

The first major step in the improvement of sensitivity was taken almost at the same time, and certainly independently, in the period 1945-6, by a French Canadian chemist, Demers, and a research team, led by Waller, at Ilford Ltd., in England, by the achievement of a large increase in the silver bromide : gelatine ratio without loss of chemical stability or increase in the background. Demers made his technical advance in the second half of 1945 as part of an attempt to perfect a new technique in nuclear research: Ilford made their advance as a direct result of national planning. The person responsible for the executive side of the planning was undoubtedly Blackett, who under the Labour Government, elected in July 1945, became the chairman of a powerful scientific committee of the Ministry of Supply. One of the tasks assigned to this committee was to consider the future of nuclear research outside the defence establishments and, in furtherance of the decision to encourage such research, it set up two panels, one concerned with the development of cyclotrons and the other nuclear emulsions. It seems probable that Chadwick, who was familiar with American and Canadian work in these fields, must have advised Blackett and, indeed, the chairman of both committees was Rotblat, a member of Chadwick's staff at Liverpool University. It is also probable that Blackett's decisions were influenced not only by his high regard for Powell's work but by his friendship with Occhialini, who went to Bristol in 1945 on Blackett's recommendation.

The first meeting of the Emulsion Panel was held on 21st November, 1945, under the chairmanship of Rotblat, with representatives of Ilford Ltd., and various universities. The university representatives were Livesey, (Cavendish Laboratory, Cambridge University), May, (King's College, London University), Perkins, (Imperial College, London University), and Powell, (Bristol University). Occhialini was not a member of the Panel but he had a considerable influence on its work. I became a member of the Panel later. Funds were made available by the Ministry of Supply and the main function of the Panel was to give contracts in those areas considered to be of primary scientific interest and importance. From the outset the main aim was seen to be the production of emulsions capable of recording charged particles of relativistic velocities, i.e. sensitive to minimum ionisation. Secondary aims were the development of suitable microscopic equipment, the loading of emulsions with various elements, and test facilities.

By the third meeting of the Panel, held on 7th May 1946, Ilford had produced beautiful new emulsions in four grain sizes, A, B, C and D and three sensitivities, 1, 2 and 3. The silver bromide : gelatine ratio had been increased to eight times.

(*) Professor G.D. Rochester sent for publication this written version of the comment made after Professor B. Rossi's talk.
above normal emulsion. As an example of sensitivity and grain size it may be noted that the C2 emulsion, later much used in cosmic ray research, had a sensitivity of six times minimum and a grain size of 0.15 \( \mu \text{m} \). At one of the early meetings a Demers' plate sent by Chadwick was shown and I recall that its sensitivity was somewhat higher than the best Ilford emulsion and that the grain size was only 0.08 \( \mu \text{m} \). Later, the Demers' formula was made available to English manufacturers, but it seems to have had little effect because the Canadian's methods were unsuited to manufacture on a commercial scale.

The production of better emulsions immediately led to their use in cosmic ray research. Exposures of plates by Perkins (B1) and by Occhialini and Powell (C2), in 1946, led to the discovery of the \( \pi \)-meson.

3. Electron Sensitive Emulsions

For the first year of the Panel's existence contracts were given only to Ilford Ltd., but in 1947 English Kodak Ltd., was invited to participate. By early 1948 the chief emulsion chemist of Kodak, Berriman, and his staff, had produced much improved emulsions and by November of the same year a sample of the first emulsion sensitive to minimum ionisation, (the NT4), was presented to the Panel. Ilford followed in September 1949 with the G5 emulsion and this rapidly became the one mainly used in cosmic ray research.

4. Comments

It is remarkable how the right technique emerged at the right time through the combined effort of scientist and manufacturer and that a medium was produced which rivalled the cloud chamber in the visual beauty of its recording of transient 'events'. As is well known the realisation of the immense scientific potential of the emulsion was due almost entirely to Powell and the Bristol School.

What has been stressed in this note is the part played by technical advances, especially the English manufacturers' contributions to the production of electron sensitive emulsions. To this could be added the later production by the same manufacturers of thick emulsions, of blocks of emulsions, and the concomitant technique of the 'temperature cycle method of development', invented by Dilworth, Occhialini and Payne of Bristol. Again, the fact that an emulsion like G5 had a relatively large grain size of 0.3 \( \mu \text{m} \) allowed Powell to introduce mass scanning by a large team of ladies (sometimes facetiously called "Cecil's Beauty Chorus") with low-power microscopes, and thus to obtain relatively quickly a wealth of data for his large team of scientists. It is unlikely that mass scanning could have been employed with finer grained emulsions such as, for example, the Demers' emulsions.