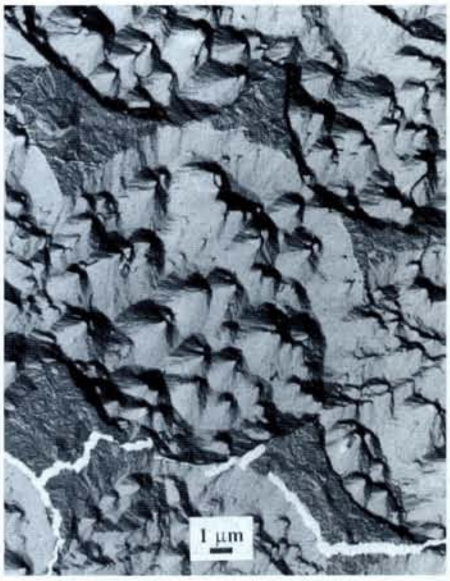
Novel Production Methods

HOT COMPACTION OF POLYMERIC FIBRES



A photomicrograph, perpendicular to the main fibre direction, of an etched cross-section through hot-compacted polyethylene fibre.

The last twenty years have seen the development of high stiffness and high strength polymers by a number of different processing routes. The materials produced range from very high stiffness fibres (up to at least 90 GPa), manufactured by drawing isotropic fibres to a very high draw ratio, to thick-section products produced by pressing or pulling polymer through a die, whose stiffness is usually limited to <40 GPa. There is therefore a requirement for high stiffness, thick-section materials. A process [*British Patent:* GB 2253420] for manufacturing such materials has been developed at the IRC in Polymer Science and Technology, Leeds University, UK. Termed "hot compaction", it takes highly drawn fibres and by choosing suitable conditions of temperature and pressure produces a homogeneous product which retains a high proportion of the original fibre properties while achieving a reasonable strength [*J. Mater. Sci.*, to be published].

The important step was the discovery that it was possible to take a fibre below its melting range and selectively melt a small portion. Sufficient pressure needs to be applied to stop the fibre shrinking and losing its orientation, but not enough to inhibit melting. It is obviously an advantage to have the surface of the fibre melt first and anything that promotes this is desirable. For a hexagonal close-packed structure (a unidirectional arrangement of fibres) only 9% of the second phase is needed to fill all the holes and bind the structure, allowing substantial retention of fibre properties.

On cooling, the molten material recrystallises to form a second, lower melting point phase, clearly evident in differential scanning calorimetry. Morphological studies show the second phase to form a transcrystalline bridge between the fibres. The spaces between the fibres are completely filled with the melted and recrystallised polyethylene. Compaction is seen to be complete, and the fibres are in the main, still largely circular in cross-section.

Nucleation of the second phase is all along the fibre boundaries so that crystals grow out perpendicular to the fibres, meeting in the middle and forming a very strong bond. There is evidence from fracture studies that failure of the compacted composite occurs within the fibre itself, suggesting the melted and recrystallised material forms an excellent "glue", and that the weakness is within the fibre itself. This is confirmed by compaction studies on a range of fibres, which show the most highly aligned fibres (*i.e.*, those with the lowest transverse properties) as having the lowest composite transverse strengths.

Fibres so far successfully compacted include melt spun, melt kneaded and gel-spun polyethylenes, polypropylene and PET. Other fibre configurations can be compacted including chopped fibres, woven fibre cloth and laminates of unidirectional fibres. All of these have improved strength compared to unidirectionally aligned fibres, but have lower stiffness. The compacted composites allow a light, tough and high stiffness composite to be manufactured using a single phase. This has considerable advantages over processing two-component composites.

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would not be possible: but not to Professor V. Marikhin, Dr. L. Myasnikova and their colleagues. They accomplished the impossible and organized a Conference which was exceptional in every way. To attend and live in St. Petersburg in the season of the white nights was a great privilege for the twenty five western scientists who joined ninety Russian colleagues at this most pleasant and scientifically valuable occasion. The only cautionary note is that, in contrast to previous experience, very few attended from countries of the former eastern bloc: obtaining hard currency is the new barrier to attendance. This will need to be addressed to ensure that in future good science and scientists from all countries are able to attend Europhysics conferences. The next meeting is titled "Transitions in Oligomer and Polymer Systems" (Ulm, Germany; 27 September – 1 October 1993).

D.C. Bassett
Chairman, EPS Macromolecular Board

IBM RESEARCH

Shifting Emphasis to Remain Vital

Dr. Karl Kümmerle, Director of the IBM Zurich Research Laboratory, discusses the impact on basic research of the company's "fundamental redefinition" announced last November, and the latest round of staff reductions.

IBM's Zurich Research Laboratory with a staff of about 200 represents a fairly small part of the Research Division (3300 staff and an annual budget of 600 M$US which has remained almost constant for several years). It is dwarfed by IBM as a whole (300 000 employees; 69 000 M$US turn-over in 1991). Founded in 1956, established on the present site in 1962, expanded in the 1970's, modernised and expanded again in the mid-1980's, the Zurich lab, with its two Nobel prizes for discovering scanning tunnelling microscopy and high-temperature superconductivity, has acquired an outstanding reputation in basic physics research. Principal interests in physics and laser science are novel microscopies to the nanometre scale, high-Tc superconductors, numerically intensive computation, nanostructure electronic devices, novel spectroscopic techniques, and materials and structures for semiconductor lasers.

IBM's Research Division was organized formally in the 1960's to seek and exploit scientific discoveries. The 1970's saw increased emphasis on transferring technology to development and manufacturing units via joint research. There evolved some 20 programmes exploiting 30-35% of research resources. The most recent shift in strategy aims to encourage competitiveness using a less monolithic approach. There are now nine relatively autonomous business units, each of which contributes an assessed amount for corporate research and can access research capabilities. As even a company the size of IBM can only handle a limited number of "lightweight" partnerships which move quickly into a large number of niche markets, there is also a trend to form joint ventures with other companies to provide sufficient growth potential. There has been speculation in the press that a shift to applied research means that about 100 posts in basic research will go in the next few years.

Editor *– One of IBM's goals was to be "famous for our science". Is this still the case? James McGroddy, your Director of Research, speaks of this science being a "vital" part of IBM. What does he mean ?*

Dr. Kümmerle – IBM has dual goals: it wants to be famous in science and technology and its science must also be relevant, in other words vital to IBM. The situation was established a long time ago and it is "burned in": it's part of the culture. We are famous by putting down stakes in selected fields as opposed to a "me too" strategy. The dual goal remains durable and nothing has changed in this respect.