PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Introduction

E. D. Hondros

Phil. Trans. R. Soc. Lond. A 1987 **322**, 309-310
doi: 10.1098/rsta.1987.0052

Phil. Trans. R. Soc. Lond. A **322**, 309–310 (1987)
Printed in Great Britain

Introduction

By E. D. Hondros, F.R.S.

Petten Establishment, CEC Joint Research Centre, Postbus 2, 1755-ZG *Petten, The Netherlands*

This meeting is concerned both with the technologies of the 1990s and of the specific contribution of advanced materials in these technologies. This implies that we are expected to be visionary: what will be the fabric of industry and technology that will constitute our societies over the next few decades? In what way do advanced materials promise the fulfilment of this vision? Even the most ardent futurologist cannot maintain that this image is crystal clear. On the other hand, the image is not a total miasma. With the historic changes in the pattern of conventional industries, it is possible to discern trends and forces leading to a new texture of industrialization.

Whatever form this will take, there are clear indications that materials will be an important factor, through the innovation of materials with intrinsic properties – physical, chemical, magnetic – which procure a performance advantage, and also in that materials with advanced properties will enable other technologies to be realized. In this sense then, materials possess a dual function: specific and enabling. We note that advanced materials may be new materials with advanced functions and also conventional materials with significantly improved properties. Thus, considering the aerospace industry, the high-temperature performance of a typical superalloy (as measured by the thousand-hour rupture strength) has twice the value of the typical alloy of 50 years ago and operates at temperatures of several hundred kelvins higher.

In this symposium, we consider both types of advanced materials: for example, defect-free cements constitute a class of advanced materials with considerable improvements over the more conventional cements. Among the materials with a high level of innovation, we consider the new ceramics: materials produced by rapid solidification processes (which possess enormous possibilities for improved properties); developments in composite materials; and new electronic artificially structured materials.

Of the forces that will shape the new industries, one discernible note is a move towards engineered goods possessing a high functional density, that is, with a unit of a given performance function being packed into a smaller size. Value is added to a product by increasing the information absorbed in its genesis, or the intellectual content per unit mass of material. This is clear for electronic materials, but it applies also to bulky conventional materials such as steels and cement.

Today there is a sense of euphoria about materials: an upsurge in interest, in planning and ideas. As will be evident from the papers presented, all industrialized countries have published or are preparing plans for centrally stimulated R & D on new materials and processes. It is as well to ask, what is the origin of this great outburst in popularity for materials? Is it a real requirement or has the scientific establishment run out of other ideas? There are indeed the cynics who claim that prevalent ideas are unoriginal and highly derivative. It is expected that this symposium will affirm the truth of materials as a crucial requirement for the

technologies of the future: this may stimulate further efforts in planning with the hope that ambitious plans are matched with support from central sources and industry.

The conviction that advanced materials will be important is borne out not only by the views of the wise men among us and by well-known reports, but also by recent systematic forecasts on the pattern of future technologies. Thus, in one such major exercise in futurology, the Japanese carried out a comprehensive 'Delphic' survey among many leaders in industry, science and academia. Out of the 20–30 major developments that were forecast with a high probability of success up to the year 2010, and which would create opportunities and industries, a close analysis showed that in a large proportion, the availability of suitable materials will be the rate-determining step in the realization of these technologies, ranging from deep-sea mining to advanced robotics and large-scale integrated devices.

In the planning of this symposium, we have considered horizontal concepts: the importance of market requirements and the transfer of new inventions into industrial usage. Today this is led by the aerospace industries, from which example we hope to learn lessons that may be applied to other engineering sectors. Defence research has also much to offer in this respect, where it is commonly viewed that economic considerations in the various innovative and development steps do not enter in the same manner as for industrial development. Hence, an issue that is being widely addressed today is, how does one stimulate the application by industry of innovations derived from defence R & D? The important steps in translating ideas into marketable products involve complex decision making based on technical and commercial considerations; this is also an aspect of advanced materials that we have included in this symposium.

There are technical considerations of another kind for facilitating the uptake of advanced materials by industry: the standards aspects. This involves a whole corpus of activities aimed to provide the basic facts and the appropriate metrology, that is, suitable measurement techniques and test methods – seemingly prosaic activities (perhaps this is why this type of work is generally neglected) – but important to enable industrial transfer. For this reason, the collaborative research programme 'VAMAS', sponsored by the Technical Working Group set up at the Versailles meeting of the 'Summit' group of industrialized countries was launched to carry out such work on a multilateral basis. These materials infrastructural activities, which will feature in future European Commission programmes will supply the prestandardization information required for the drafting of specifications and codes of practice; this includes work on materials assessment systems, databases, as well as appropriate design methodologies for advanced materials in appropriate performance conditions.

The interesting set of papers that follows will no doubt illuminate us on our theme: in what manner do advanced materials promise society a better future?

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES