

ADVANCED MATERIALS

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Materials Federations— The State of Play

Editorial Essay

By Robert W. Cahn*

In May of this year, the Federation of Materials Institutes (of the United Kingdom) gave the press the news of its impending creation. The Institute of Ceramics, the Institute of Metals and the Plastics and Rubber Institute announced the formation, on June 1, of the new Federation.

The beginnings of the new federation lie two years in the past: the Institute of Ceramics and the Plastics and Rubber Institute, both British professional bodies, federated in November 1986. This decision represented, in the words of one of the senior officers concerned, 'a natural meeting of minds.' Earlier this year the Institute of Metals, London, decided to join the new federation, and soon afterwards the creation of the new body was announced to the world. What lies behind this innocuous news item?

A dignified contest has been in progress for many years between the drive to mark the emergence of the new super-discipline of Materials Science and Engineering (MSE) by the creation of corresponding professional institutes, and the equally strong urge to strengthen the existing sectional bodies in the traditional fields of metallurgy, ceramics and polymers, as well as the newer fields of electronic materials, composites, solid-state chemistry, and others.

Probably the earliest manifestation of the MSE lobby's activity was the formation, in 1963, of the (British) Materials Science Club. The initiative stemmed from the late Mr. *Leslie Holliday* of the Institute of Chemical Engineers and several colleagues in the same Institute. At its apogee, this Club had several hundred members: it was always administered from within one of the British industrial companies to which its members belonged, first Shell and subse-

quently other bodies in the chemical engineering field—it never reached the dignity of a fulltime secretariat—and it held frequent meetings focused on industrial applications of various fields of MSE. The Club never sought to appropriate the other functions of a professional body and in particular it never tried to arrogate to itself the role of a professional qualifying body. This role may seem surprising to some readers outside the U.K. ... but in that country, the right to put letters such as F.I.M., F.R.I.C. or F.I.P.—or 'Chartered Engineer' or 'Chartered Physicist'—after one's name has always been highly prized and has

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always enhanced the holder's chance of securing a good post in industry—though it rarely influenced academic appointment committees! Some four years ago, the Materials Science Club, which had fallen on hard times, applied to amalgamate with the Metals Society, itself soon to become part of the Institute of Metals, and thereupon became one of its 'activity groups'. Existing members who were not metallurgists—the majority—were invited to join the Institute of Metals on favorable terms, but few accepted this offer, and the Materials Science Club, having fulfilled what was expected of it, is now to all intents and purposes dead.

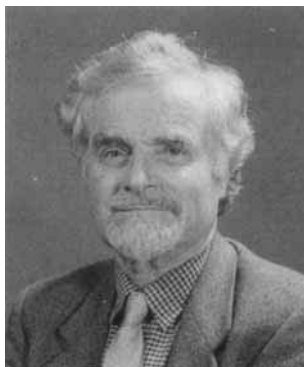
The history of this pioneering Club illustrates a tendency which, rightly or wrongly, worries many materials scientists and engineers (let us call them MSEists) who are not primarily metallurgists. They have for some years perceived the large national metallurgical bodies as being engaged in a ruthless takeover campaign for the world's MSEists. Where Britain is concerned, the evidence for this worry is not strong: The Materials Science Club takeover, though it seemed innocuous enough, perturbed some; and the Institute's research journals, which had been entitled *Metal Science* and *Metals Technology*, were conflated to form *Materials Science and Technology*. The Institute of Metals sought to persuade ceramists, composite and polymer people to publish in its revamped periodical; when they did (as one eminent polymer specialist declared to the writer) they might receive no requests at all for reprints, which of course served as clear evidence that their papers had been read by few of those at whom they had been directed. The Institute of Metals certainly made it clear to the world that it wished to broaden its field of activities, after long years when much of its membership fiercely resisted any such broadening. The Institute may be forgiven if it feels aggrieved that, when at length it has reacted positively to this long-standing pressure, it has encountered a strongly negative reaction from some of its sister institutions! This is certainly unfortunate ... but, as we shall see below, this is probably a defensive response to the buccaneering activities of one of the American metallurgical societies.

Another body which has been in existence for some years in Britain is the Materials Forum, which owes its ex-

istence to the initiative of the (British) Institution of Mechanical Engineers and, more specifically, to the advocacy of a distinguished mechanical engineer, *Sir Hugh Ford*. The Materials Forum is intended to be a materials users' representative body. This body seeks to cover a wider range of engineering materials, and also to play a political (lobbying) role. By no means all British MSEists would accord the Metals Forum such a central position, and indeed would consider its claims as yet further evidence of metallurgical hubris!

America is another matter altogether. There are two major metallurgical bodies in the U.S.: The Metallurgical Society (TMS) of the American Institute of Mining, Metallurgical and Petroleum Engineers, and the American Society for Metals. The former has always maintained a decent reticence vis-à-vis its sister societies, but the ASM has recently gone unashamedly on the warpath. It has rechristened itself 'ASM International ... a Society for Materials', it has opened an ASM-Europe office, has created ASM 'chapters' in Benelux and Finland and has sought to create similar chapters (in some cases involving attempted takeovers of existing bodies) in countries such as India. This activity (which in the business world would be called an attempt at hostile takeovers) has not gone unnoticed and in this writer's view may have played a significant role in promoting the federation initiatives such as that between the ceramics and polymer bodies in Britain two years ago. Following that particular initiative, the Institute of Metals felt bound to become involved, which showed an impressive capacity for taking a long-term view.

The ASM action, and the subsequent actions in Europe, were no doubt partly a response to the runaway success of the (American) Materials Research Society, formed in the early seventies by a group of industrial materials physicists and, to a lesser extent, chemists who were frustrated by the lack of interest of the American Physical Society and American Chemical Society, at that time, in their concerns. The MRS, which now has more than 6000 members, has excited considerable suspicion and even hostility among some metallurgists in America and is perceived as a threat to the viability of the metallurgical societies by some of their members. While a European clone has recently started operations—the E-MRS or European Materials

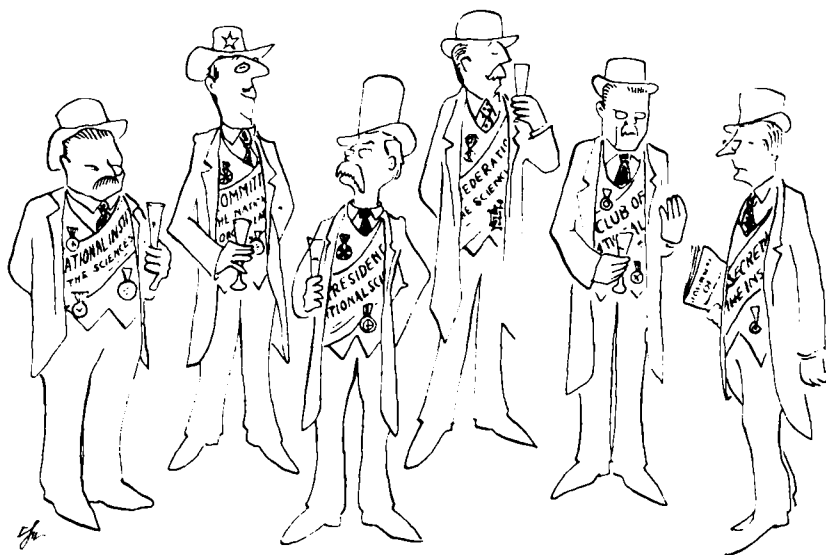


Prof. Robert W. Cahn was for many years Professor of Materials Science at the University of Sussex, UK, following that with a shorter period as Professor of Physical Metallurgy at the University of Paris-Sud. He is now retired, and attached to the Department of Materials Science and Metallurgy at Cambridge University, in the capacity of Senior Associate, and continuing to do research. His researches have been in various aspects of physical metallurgy, including ordered alloys, recrystallization of deformed metals, twinning and rapid solidification. He has been active for many years as an editor and correspondent: jointly with others, he created the Journal of Nuclear Materials and the Journal of Materials Science, has edited three editions of a text on Physical Metallurgy, has for 16 years edited a monograph series for the Cambridge University Press, has been materials science correspondent for 'Nature' for 20 years, is a principal editor of the new Journal of Materials Research and has embarked on a new editing venture, a series of 18 texts in MSE, for the publishers of 'Advanced Materials'.

Research Society—it is at far too early a stage to be a serious threat to existing European bodies, but nevertheless the evidence is that it is already viewed with alarm.

Even before the Federation of Materials Institutes—to give it its formal name—began operations in Britain, other defensive initiatives had been seen in Europe. About five years ago, the various national polymer societies of Europe formed a European Polymer Federation, and last year, under the presidency of a distinguished Dutch ceramist, Dr. R. Metselaar, the ceramics societies of Europe formed the European Ceramic Society (in fact, though not in name, a federation) which is soon to hold its first international conference. This ceramics initiative apparently owed much to the discreet support offered by the American Ceramic Society, which wished to see a strong Europe-wide activity in ceramics (perhaps to counter what it may have perceived as metallurgical presumption!) Until this year the metallurgical bodies of Europe had not yet federated in any shape or form, although for some years their administrators have met regularly to prevent timetable conflicts with respect to their various national conferences. Indeed, such efforts to avoid timetable conflicts constitute one of the more basic objectives of European federations. However, as this editorial is being revised for press, an invitation is being circulated to a conference, entitled Euromat '89 and sponsored by a Federation of European Materials Societies! On closer examination, their brandnew Federation consists of the national metallurgical bodies of Britain, France and Germany, with the Swiss Society of Materials Technology for seasoning. The administrative seat is in Germany, so the initiative presumably stemmed from the Deutsche Gesellschaft für Metallkunde. Once again, metallurgical hubris has prevailed ... the latest Federation claim to represent all materials, not just metals!

Reverting to the recently formed (British) Federation of Materials Institutes, this body is now taking active steps to enlarge its scope. Negotiations with the recently formed British Composites Society are at an advanced stage; there have been preliminary contacts with the Institute of Textiles and with other bodies. The Federation is strongly placed financially. Its administrative headquarters will soon move to the premises of the Plastics and Rubber Institute in London, and Sir Geoffrey Ford, the recently retired Secretary of the Institute of Metals, has already taken over as Secretary of the new Federation. The Chairman is Sir John Collyear, an industrialist who was Chairman of a Committee which, in 1985, was charged by the British Government with formulating a "Programme for the



Inaugural party, or ... wearing many hats

Wider Application of New and Improved Materials and Processes". (Their excellent report, like so many others in the materials field, led to no action whatsoever.) The Council will include, inter alios, the Presidents of the constituent societies. The aims of the new Federation are announced as being to "coordinate the activities of professional bodies and learned societies involved in the science, engineering and applications of materials in order to provide unbroken coverage of the entire field; improve services to members, to industry, and to the whole materials community; and to promote a wider understanding of engineered materials." The only possible response to that is: Amen!

Even more to the point is the following forthright assertion: "The three founding societies ... see as their ultimate aim the formation of a single Institute of Materials in the UK." This is undoubtedly difficult to achieve; the Institute of Metals will be the first to concede this, in view of its long years of effort directed, successfully in the end, to its mergers, first with the Iron and Steel Institute and then with the Institution of Metallurgists (which last was largely a professional qualifying body). One should not forget the trauma suffered by the Institute of Physics in London, many years ago, when it engineered its merger with the Physical Society; a very eminent physicist was reported as saying, in a moment of exasperation, that he supposed his Nobel Prize had really been awarded for his role in forcing through the merger!—Nevertheless, for the first time the objective of creating a materials institute in a European country has been announced, not unrealistically by a single existing body but rather by a federation of several such bodies: one can only hope that the creation of the metallurgically biased Federation of European Materials Societies will not interfere with the objective of eventually creating a British Institute of Materials.

An interesting question is the future relation between the international discipline-based European federations such

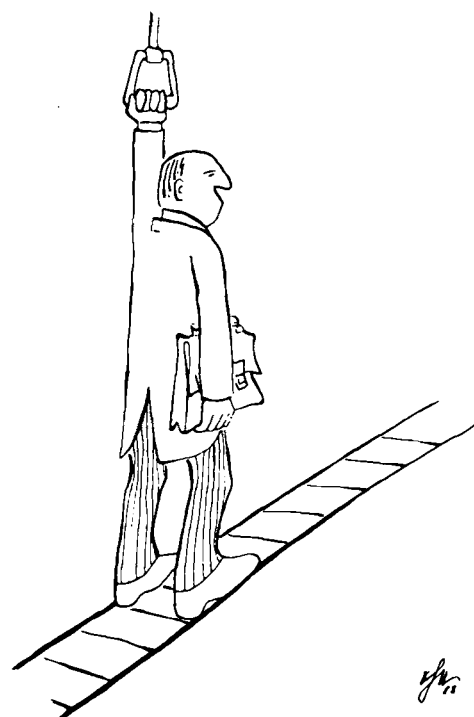
as those in the ceramics and polymer fields (and possibly a future metallurgical one), and the trans-disciplinary single-nation federation represented by the new body. It seems that no initiatives have yet been seen in other European countries to establish trans-disciplinary federations or societies in these countries. Perhaps we face a competition between single-nation trans-disciplinary bodies and international single-disciplinary bodies. One possibility, idealistic no doubt, is that the projected British Institute of Materials will actually come into existence and act as a template for a large European Institute of the same kind. That will certainly work better than the Federation of European Materials (i.e. Metals) Societies! A genuine European Materials Institute is certainly quite some years ahead and—who knows?—by then the European Materials Research Society, at present still a fairly modest enterprise, may have taken off as successfully as its American progenitor.

There have been suggestions in the foregoing that metallurgical bodies fear the MRS and that non-metallurgical bodies fear the metallurgists—perhaps more than they fear the MRS. The fear, so far as can be assessed, seems to be that the existing, traditional functions of the many bodies involved—the organizing and publishing of conferences, the holding of short discussion meetings, the publication of learned periodicals and news-filled house journals, the pleasant activity of formal dinners and (possibly the most important psychologically) the behind-the-scenes influencing of ministers and prime-ministerial science advisers—that all these varied activities are at risk from predators of one kind or another. The response of the ASM has been to undertake preemptive strikes across the world, and this is really rather odd, taking into consideration the fact that bodies such as the ASM have no shareholders to clamor for more profits. It is hard to see what benefit is achieved, for such a society, in growing beyond a certain size and income. Indeed, the MRS, ASM and AIME alike have all grown to a size which makes their meetings somewhat uncomfortable as social occasions. The most curious aspect of the situation, perhaps, is that the MRS has to be regarded, for the present, as a sleeping giant so far as political influence goes. It is so busy running and publishing specialized symposia, publishing one of the best house journals in the business and getting its new learned periodical off the ground, that it has not found time or inclination to lobby members of Congress for funds and to bend the ears of the President's Science Advisor or of the beleaguered minions of the National Science Foundation. That may change, of course—voices are beginning to be raised inside the MRS in favor of a higher political profile—but for the moment there are many smaller bodies which are far more active politically, for weal or woe. So perhaps the widespread apprehension is premature. There exists, in fact, a primarily politically oriented body, the Federation of Materials Societies (of the U.S.A.), founded in 1972. It is run from a small office in Washington, and unites twelve

societies (in metallurgy, ceramics, engineering and chemistry ... i.e. polymers, electronics and crystal growth; The Materials Research Society is not a member). It organizes impressive, biennial conferences devoted primarily to policy issues, and through these seeks to influence the Administration and Congress. The Executive Director is an expert in public relations. The participants in the conferences are mostly research directors and other policy makers. The technical papers are surveys, not research reports. One wonders whether one of the European federations will go this way ... targeted on the Brussels bureaucrats!

One other consideration warrants careful thought. As stated, the Institute of Metals has sought to broaden the scope of its technical journal, and encountered some difficulty in doing so. Presumably, its partners in the new British Federation will now press it to leave ceramics to the ceramists, polymers to the polymer scientists and composites to the compositers. If and when the Federation is replaced by a (national) Institute of Materials, that will be the time to go for a broad materials journal. But, in the view of the writer (who is an editor of long and varied experience) this will only work if the old journals close down and an entirely new journal, under entirely new management, starts up. Journals are like the Old Man of Siam:

*There was an old man of Siam
Who said: "I perceive that I am
A creature that moves
In predestinate grooves,
Not a car, not a bus, but a tram."*



"... not a car, not a bus, but a tram"

Within a year or two of the creation of a new journal, its scope and readership become set in stone (or grooves), and thereafter extensions of either, however sincerely sought, become ever more difficult. The MRS started its new journal after the Society had become established in the eye of the technical public, and was thus able to aim immediately at a wide scope and readership; even so, it has had difficulties to overcome ... a tendency by readers to suspect the new journal of electronic favoritism, and problems in extending readership across the Atlantic. It has scored with a striking innovation, however: it may well be the first

learned periodical (as distinct from house journal) to be distributed free to all members who pay their modest membership subscriptions. There is undoubtedly much to learn, on this side of the Atlantic, from the MRS's new *Journal of Materials Research*.

For better or worse, Europe has embarked on a new route marked with much promise and numerous difficulties: it will be next to impossible to stop at a halfway point, and we may all expect to witness a rapid succession of mergers, federations and recreations. Good luck ... bonne chance ... zum Wohle!

New Donors for Molecular Organic (Super)Conductors and Ferromagnets**

Organic Metals
Organic Ferromagnets
Charge-Transfer Complexes
1,3-Dithiol-2-ylidene Donors

By Zen-ichi Yoshida* and Toyonari Sugimoto

1. Introduction

Synthetic chemistry has in the past been directed towards "structural" synthesis, in which compounds of known structure (e.g. natural products) or structure designed new systems (e.g. novel π systems) are the synthetic targets. This sort of chemistry will continue to be important in the future. However, "functional" synthesis, directed towards synthesizing organic compounds with novel functions, has recently started to emerge as a very important new field of chemistry, which will make valuable contributions to creating new advanced materials. Since we have already succeeded in creating an excellent new molecular energy storage system ("DONAC") based on our concept, in this review we shall discuss experiments aimed at synthesizing organic compounds with interesting electrical or magnetic properties.

The discovery in the early 1970's that single crystals of a tetrathiafulvalene-tetracyanoquinodimethane (TTF-TCNQ) charge-transfer (CT) complex showed metal-like electrical conductivity^[1] marked an epoch in a new area of chemistry and physics. The energetic investigations that followed led in 1980 to another big discovery, that of the first organic superconductor, (TMTSF)₂PF₆, where TMTSF is tetramethyltetraselenafulvalene. This has a critical temperature T_c of 0.9 K under a pressure of 12 kbar.^[2] Looking back on the brilliant history of organic conducting materials, one recognizes that two organic molecules originally synthesized for their structural interest as novel π -electron systems, TTF^[3] and TCNQ,^[4] played a crucial role in this new scientific field. From this viewpoint it can be said that organic and organometallic syntheses, which have yielded a number of promising organic molecules used to prepare interesting and useful organic materials, provide a springboard for new developments in this field.^[5] However, the electrical, magnetic and optical properties of organic solids arise from special types of interactions between several organic constituents in ways that are as yet little understood. Therefore, in addition to the preparation of organic compounds that show promise as such constituent molecules, there is an urgent need to develop guiding concepts regarding the problem of crystal growth, to bring a deeper understanding of the properties of organic solids.

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