Summit Working Group on Technology, Growth and Employment

VAMAS

Versailles Project on Advanced Materials and Standards

Canada CEC FRG France Italy Japan UK USA

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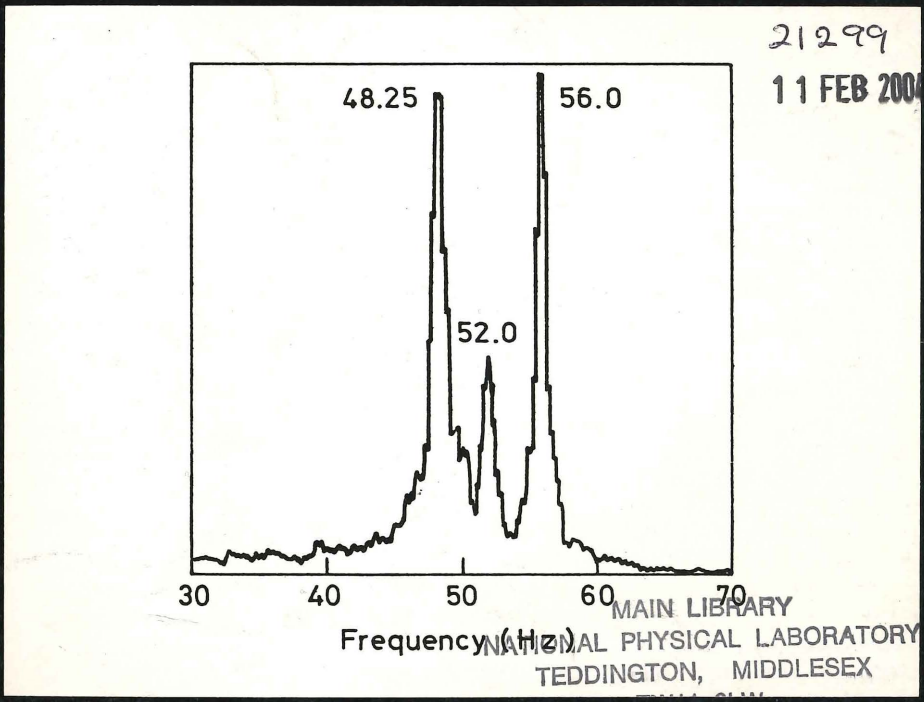

VAMAS

VAMAS is a scheme to stimulate the introduction of advanced materials into high technology products and engineering structures with the overall aim of encouraging international trade therein:

- through international agreement on codes of practice and performance standards
- through multilateral research aimed at furnishing the enabling scientific and metrological base necessary to achieve agreement on standards.

THE AIMS OF VAMAS

The background to this scheme for multilateral collaboration on advanced materials research lies in the deliberations of the Working Group on 'Technology, Growth and Employment'. This was set up by the Seven Heads of State and Government and Representatives of the European Communities at the Economic Summit of Versailles in June 1982 to prepare proposals to exploit the immense opportunities presented by the new technologies and 'to remove barriers to, and promote, the development of and trade in new technologies'.

Among the recommendations for collaboration on science and technology (which ranged from 'Food Technology' to 'High Speed Trains') was that on 'Advanced Materials and Standards'. Here *inter alia* the Working Group noted:

> 'We all recognise the critical importance of the materials used in mechanical, constructional and electronic engineering.
>
> The objective of the present proposal is to encourage the setting up of codes of practice and specifications for advanced materials on an internationally co-ordinated basis. Such codes create the conditions for the rapid adoption of materials by industry. New materials enlarge technological perspectives and catalyse innovation.'

The members of the international Steering Committee set up to pursue this theme strongly affirm the basic truths expressed in this message, believing that the advent and acceptance of suitable materials with advanced properties and performance will be the rate determining step in the introduction of those new technologies that will shape the fabric of society and industry in the decades ahead.

In terms of their engineering applications, such materials will permit lighter constructions, longer life in service, increased efficiency, and improved safety. To encourage their adoption, there must exist associated codes of practice and standards. These convey the assurance to the user of performance in service and they instil confidence to switch from traditional materials to advanced materials. Standards not only stimulate the acceptance of new materials, but also help to encourage the use of improved existing materials.

Although it is not the direct aim of VAMAS to draft new Specifications on materials – this is the job of national specification drafting committees – there is a definite and unique role for this body. This is the provision of the enabling technical base which will accelerate the production of internationally agreed standards and codes of practice. Here, we envisage

'underpinning' activities, including: the development and validation of appropriate measurement techniques and advanced test techniques relevant to service conditions; the design of test samples to measure properties in complex conditions of stress and chemical environment; the provision of critical physical and chemical data; the exploitation of large centralised test facilities; the development of computer aided automated testing machines; and property predictive techniques and design methodologies appropriate to advanced materials.

The Steering Committee, the composition of which is shown on page 7 has agreed on the modalities of operation and a Memorandum of Understanding will soon be signed by the participating countries. Furthermore, collaboration will be conducted on the basis of 'concerted action' or a multilateral cooperative research club, in which each participating member agrees to carry out a specific complementary component of a larger programme and in return gains access to the total research output. This structure reflects the view of the Versailles Working Group that 'with current economic difficulties and with national budgets subject to greater constraint, it makes even more sense to cooperate internationally'. This means that each party to the collaboration must find its own research resources from the appropriate national agencies.

A number of Technical Working Parties have already been launched, each on a separate materials theme, and others are being developed. It is these bodies that have the important task of planning and integrating the Research Programmes. The Chairman of a Technical Working Party, generally a distinguished specialist in the field, has the responsibility for organising the structure for the collaboration.

Various materials themes have been considered and already it has been decided to promote several of them. The themes for action and the others under review are presented below.

TECHNICAL WORKING AREAS

Four Technical Working Areas have been approved and others are under consideration. Anyone wishing to learn more about a specific area should contact either the Chairman of the Working Party or his national representative on the Steering Committee.

Technical Working Area

WEAR TEST METHODS

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Wear is, apart from corrosion, economically the most important material deterioration process. It is defined by OECD as 'The progressive loss of substance of a body occurring as a result of relative motion at the surface'. Several studies have shown that in the highly industrialised countries the economic losses due to wear and wear-related phenomena amount to 1 to 2% of the gross national product. Because of the complexity of wear, the many wear processes and the numerous influencing parameters, there is a lack of industrially relevant techniques and methodologies of wear testing. Thus it would be of economic and technological benefit to carry out international collaboration in wear

research and to establish agreed standards on wear testing, in order to mitigate wear-induced material losses and to introduce advanced wear-resistant materials to contemporary industrial technologies. The overall aims and targets of the VAMAS project on WEAR TEST METHODS may be summarised as follows:

- Improvements to the reproducibility and comparability of wear tests by developing internationally agreed wear test methodologies.
- Characterisation of the wear behaviour of 'advanced materials' (like ceramics and wear-resistant surface coatings), in comparison with conventional materials.

In the international collaboration on WEAR TEST METHODS, members from the technical communities of all VAMAS countries, that is Canada, France, Federal Republic of Germany, Italy, Japan, United Kingdom and the United States of America, will participate.

Technical Working Area

○ SURFACE CHEMICAL ANALYSIS ○

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In recent years the diverse information derived from surface chemical analysis has become increasingly important to the development of advanced materials in modern technologies and the improvements involving reaction layers, films and coatings. The principal techniques in common use are Auger electron spectroscopy, X-ray photoelectron spectroscopy and secondary-ion mass spectroscopy. Accurate surface analyses require: (i) knowledge of the principles of the measurement method; (ii) knowledge of the behaviour of the measuring instrument; and (iii) correct interpretation and expression of the final measured result.

Standards for the measurement of surface composition with known accuracy and for the reliable determination of chemical state will require: (a) a base of principles, definition of terms and suitable equations; (b) reference procedures for the measurement of intensities and spectral features; (c) procedures and data for instrument calibrations; (d) reference data for materials parameters such as elemental sensitivity factors, matrix terms, chemical state spectra, ion sputtering rates, etc; and (e) standard methods for specifying an analysis. Standards are required for ion sputtering, which is used to obtain composition versus depth information, as well as for the spectroscopic techniques. Activities in the member countries have been reviewed and needs identified. All the VAMAS countries are participating in this working area.

Technical Working Area

○ POLYMER BLENDS ○

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Polymer blends are mixtures of structurally different homopolymers, copolymers, terpolymers etc which may be either homogeneous or multiphase and which can be pre-

pared with standard processing equipment used for simple resins. The great advantage of blending is that a material can be produced with a unique combination of properties to meet the specific requirements of the customer. Also, the benefits of synergism can be used in some cases to give a higher performance material at an acceptable cost.

The use of polymer blends is growing at an impressive rate and US production of these materials in 1983 was valued at $340 million for applications in aerospace and in other specialised industrial uses. The major growth in the near future is expected to be in materials with resistance to high temperatures, electrical conductivity and good low temperature impact properties.

The purpose of the VAMAS project will be to coordinate international research activities aimed at developing a complete understanding of the principles of blending in order to provide a basis for compositional and performance standards for these important materials. To achieve these objectives it will be necessary to mount an inter-disciplinary effort involving specialists in thermodynamics, colloid science, rheology (melt flow of multiphase systems) processing technology, mechanical property assessment and performance evaluation.

VAMAS provides the opportunity to bring the necessary expertise together in a framework of international collaboration to develop a coherent technical base for the further exploitation of these materials. It is envisaged that one output from the programme will be a data bank for design and processing applications.

Technical Working Area

○ CERAMICS ○

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Ceramics, among the earliest materials used by man, now offer the promise of advanced materials with outstanding high temperature performance, hardness and wear resistance. The slow evolution of engineering ceramics is partly due to difficulties in improving the properties of the materials, to difficulties in improving the production processes, and to the poor dialogue between the ceramist and the user. These issues raise the need for standards.

For many applications, the potential performance of ceramics cannot be expressed in terms of the same properties as the metals they might replace in engines, machine tools, bearings and bioengineering materials. Standards should be established in relation to the specificity of ceramic materials and not as a translation of existing standards on metals. They should be defined for the convenience of the users as well as of ceramists. The test techniques should provide quantitative information for users. The standards here must be carefully set if we are to see the rapid industrial development of engineering ceramics.

The main aspects of interest to users are the brittle behaviour and durability of ceramics. Therefore, relevant standards should help to characterise the brittleness and the sensitivity to time-dependant phenomena, in order to be useful for life predictions. Three priorities will be pursued in the framework of the international collaboration of VAMAS:

- The thermal shock resistance, chiefly for cyclic conditions (thermal fatigue).
- The mechanical strength, mostly for long-time applied loads, under various environments (static fatigue).

- The frictional properties and the wear resistance. This topic should be closely connected to the WEAR TEST METHODS theme (Chairman: Prof Czichos).

The first step will be to define the most significant physical parameters; the second to determine what tests are the most suitable; and the third to characterise the test conditions.

TOPICS UNDER CONSIDERATION

For these topics, except WELD CHARACTERISTICS, a member of the Steering Committee has responsibility for formulating a proposal.

WELD CHARACTERISTICS

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The advent of steels with very low contents of sulphur to improve fracture toughness has led to difficulties due to lack of penetration during automatic welding using the tungsten inert gas (TIG) technique. The observed behaviour can be explained on the basis of surface-tension driven flow within the weld pool, and the presence of small amounts of surface-active constituents such as sulphur may have a controlling influence. The overall aim will be to produce a compositional standard to improve the consistency of weld penetration in the TIG welding of steels. This work will be coupled with a project to examine the fracture toughness of welded joints in steel which is at the definition stage.

HOT SALT CORROSION RESISTANCE

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In gas turbines operating in a marine environment, either in aircraft and ships, or for power generation in off-shore installations, severe corrosion problems result from the ingestion of salt in combination with sulphur present in the fuel. The choice of a suitable test method for the evaluation of the hot salt corrosion resistance of individual alloys has been a matter of some debate but there is now a substantial amount of information available in Europe and the USA relating the results from various test techniques to performance in service. This project will assess and compile this information and prepare recommendations for an optimum technique which will serve as a basis for internationally acceptable test procedures.

POLYMER COMPOSITES

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A preliminary assessment has indicated that commercial interests in composites are very great, the science very complex and the range of materials types very wide. Consequently, it is necessary to initiate a VAMAS activity which is sufficiently focussed to ensure a practical outcome, which does not conflict with commercial interests, and which will provide a significant level of support to standards activities. Prof C Bathias is formulating a proposal in consultation with Dr FJ Lockett of NPL and Dr L Smith of NBS.

BIOENGINEERING MATERIALS

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A surprising range of materials is now used in the human body, including alloys, polymers, composites, cements and adhesives for bone replacements; hydrogels for soft tissue replacement; memory plastics and piezoelectrics. Internationally acceptable test methods are needed for wear, biocompatibility and adhesion to encourage the acceptance of bioengineering materials and help to remove any artificial barriers to trade in these products.

OTHER TOPICS

Further topics being discussed are cryogenic materials, fracture mechanics, non-destructive testing and energy content of advanced materials.

VAMAS ORGANISATION

VAMAS is co-led by UK and USA. The current Chairman of the Steering Committee is Dr E D Hondros, the alternate Chairman is Dr R Mehrabian, and the Secretary is Dr T I Barry, UK.

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Cover:
Levitated drop: From a Fourier analysis of the oscillations the surface tension, which strongly influences weld characteristics, can be calculated.