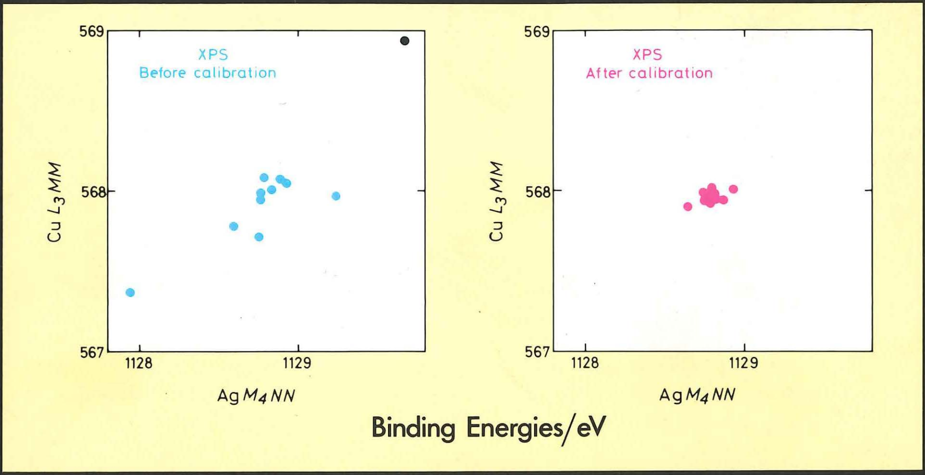
Summit Working Group on Technology, Growth and Employment

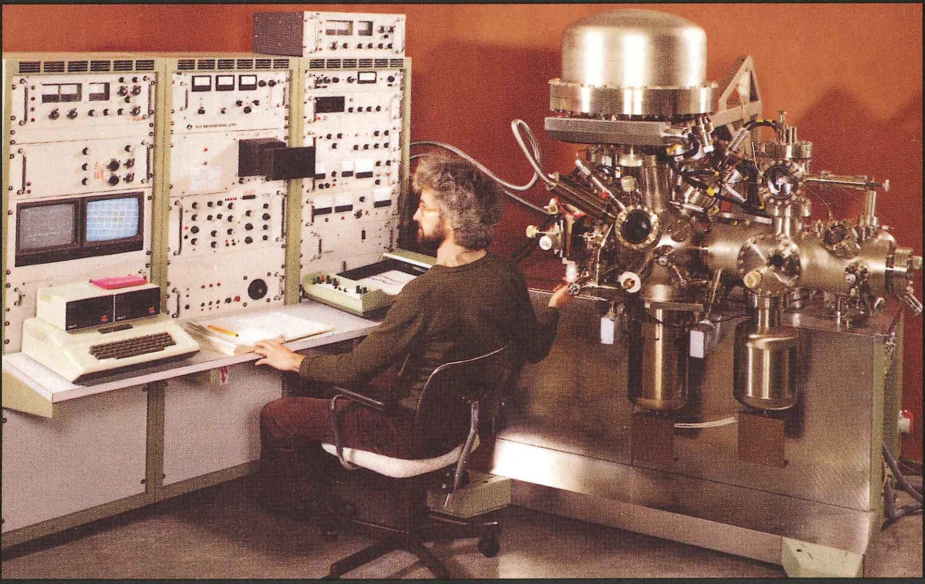
•VAMAS•

Versailles Project on Advanced Materials and Standards

Canada CEC FRG France Italy Japan UK USA

Bulletin No. 2 • July 1985





• 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 ROLE OF VAMAS •

The VAMAS project on multilateral materials research collaboration represents one of the projects announced by the Working Group on 'Technology, Growth and Employment', which arose from the Economic Summit at Versailles in 1982. In the meantime, while the project has been taking shape, we have seen increasing effort both nationally and internationally devoted to materials science and technology. The message has been received clearly and there is now a strong conviction among industrialised countries that materials will form one of the pivots of technological growth in the future. The concept underlying VAMAS is the need for collaborative research to strengthen the technical base for accelerating agreement on codes of practice and standards which cover the performance of advanced materials. It is the role of VAMAS to help ensure that the development of codes of practice keeps pace with developments in advanced materials - whether these involve fresh innovations or the more conventional materials with advanced performance applications.

Since the first issue of the Bulletin, the Steering Committee has launched additional activities: in superconducting and cryogenic structural materials; hot salt corrosion resistance; polymer composites; weld characteristics and bioengineering materials. Other themes have been discussed. A most encouraging note encountered is the positive acceptance of VAMAS-type R&D by those engaged directly in specialist research fields. They appreciate the value of cost-shared Club activities - the multiplier effect - especially in those difficult areas of research which require the accumulation and validation of reliable data.

From the science policy perspective, we note the enthusiasm of colleagues from countries stretching from Japan to North America and Europe: here there is a strong affirmation of the importance of carrying out enabling research of a pre-competitive nature in a multilateral way. In turn, we have learned to appreciate the problems of carrying out research in an equitable manner by parties in different continents and we have had to face difficulties in setting up acceptable structures. The nature of this cost-shared activity is a test of the good-will among all the cooperating parties, since there is no provision of central funds and thus no obvious incentive to join in the collaboration.

The essential link between the output of VAMAS projects and the national standards writing bodies must be emphasised. We are pleased to see that participants in this project are separately forging the links with the institutions responsible for drafting standards in their countries - institutions which have without exception welcomed this R&D activity, recognising it as an instrument to help set up standards more quickly and based upon agreed data and principles.

TECHNICAL WORKING AREAS

Nine Technical Working Areas have been approved. 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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The first meeting on this Working Area took place in Vancouver on 19 April 1985 at the conclusion of the ASME meeting on Wear of Materials. Professor Dr H Czichos chaired the meeting hosted by Dr Howard Hawthorne of the National Research Council of Canada.

The main objectives of the Working Party were identified as:

- Improvements in the reproducibility and comparability of wear test methods by developing internationally agreed wear test methodologies.
- Characterisation of the wear behaviour of 'advanced materials' in comparison with conventional materials, advanced materials being defined as ceramics and inorganic coatings.

All national representatives expressed their enthusiastic approval for this very timely initiative and reported that meetings had already been held at separate national levels. At least four laboratories in each country will actively participate in a round robin test procedure.

A methodology for a ball on disc wear machine evaluation was discussed and experimental details were agreed. Because of some doubts about the actual conditions for wear tests, groups in Germany and the UK will carry out a preliminary investigation to establish the precise test conditions.

Both conventional steel (A151 52100) and ceramic materials (alumina, followed by silicon carbide) in their final machined condition will be supplied to the cooperating laboratories with the requisite testing facilities, and the round robin tests will commence in August 1985. Cooperation with the CERAMICS Working Party has been established through the supply of ceramics by Professor Boch. Precise records of all environmental conditions as well as load and speed will be maintained for each test. Emphasis will be placed on interpretation of the friction and wear. Action will be based upon the post examination of the worn ball, disc and debris.

It was stressed by a number of representatives that Industry will want to know how this work will be applied and how it will benefit. In this respect there was considerable discussion which concentrated on technology transfer and how best this might be achieved in both the short and long term. The standards already available in the USA and Germany and the value of these to both investigators and industry in both countries were discussed.

The possibility of publishing wear data in the form of design guides and also as a 'wear atlas', to aid in the processes of diagnosis of industrial problems as well as their economic solution, was extensively discussed and in principle these ideas were accepted with enthusiasm by the Working Party. It was recognised that considerable effort would be required and various ideas for initiating this and defining the boundaries of the project would be explored through the Chairman. Industrial contacts would be approached through a questionnaire to determine the conditions existing in their plant and equipment and also what tests they are currently using to determine both fundamental and *in situ* friction and wear characteristics.

The meeting concluded with a review of the importance of the wear test round robin methodology and the ultimate transfer of technology to industry. Chairman Czichos suggested that rapid progress could be achieved and the results of the first stage of the round robin tests would be discussed early in 1986.

Technical Working Area

○ SURFACE CHEMICAL ANALYSIS ○

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Surface chemical analyses are made on a large variety of advanced materials (e.g. semiconductors, polymers, metals, oxides, glasses) after fabrication and at various times during their service life for process optimisation, failure analysis, and quality control. Although the surface analysis methods in use are extremely valuable, standards of practice, reference data, and reference materials are needed so that measurements of known accuracy can be routinely obtained.

The principal objectives of the SURFACE CHEMICAL ANALYSIS Working Party are: (i) to ensure international coordination of standards-related activities before national standards are adopted, and (ii) to stimulate the development of needed standards on an international basis. Plans for specific projects are being developed in all VAMAS countries and projects are being initiated in 1985:

- One example is the planned production in Canada of thin films of Fe_2O_3, NiO and Cr_2O_3 with thicknesses of about 25 nm. These films will be characterised in Canada and other VAMAS states for use as reference materials.
- Another example is the development in France of reference methods and data for the calibration and characterisation of electron spectrometers. This work will be coordinated with related projects in the UK and the USA. The importance of such calibration is shown on the front cover of this Bulletin. The diagram shows reported data from X-ray photoelectron spectrometers, both as normally operated, and after calibration with reference data.
- A third example, which emphasises the aspect of homogenisation, is the preparation of a review article by authors from UK and USA that will summarise and categorise the various formulae for quantitative surface analyses by electronic spectroscopic methods in different analytical situations (for example, samples with adsorbed layers, thin films, varying compositions and inclusions).

These three examples relate to the three sectors, reference materials, reference data and reference methods which, together with standard terminology, will form the main focus of effort on surface chemical analysis.

It is expected that many of the national representatives will meet during the European Conference on Application of Surface Analysis, Veldhoven, The Netherlands, 14–18 October 1985. This first meeting will be an opportunity to review progress and to develop plans for additional cooperative activities. It is expected that VAMAS-related sessions may be incorporated in a number of national and international conferences in the future.

Technical Working Area

○ POLYMER BLENDS ○

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The first organisational meeting on POLYMER BLENDS took place on 15 April 1985 in the Industrial Materials Research Institute, Boucherville, with the following participants in addition to the Chairman: Dr J G Wurm (CEC), Prof D Froelich (France), Prof G Pastuska (FRG), Prof E Butta (Italy), Dr I K Partridge (UK) and Dr C C Han (USA). The Secretary is Prof R E Prud'homme (Canada).

The long-term aims of the programme were agreed as well as the following shorter-term objectives:

- Selection and acquisition of 3 tonnes of polycarbonate and linear low-density polyethylene.
- Preparation of five blends with different concentration of ingredients.
- Collection of existing data on the behaviour of this sytem.
- Conduct of round robin tests according to an agreed schedule.
- Comparison of results.

An equivalent exercise will be performed on polystyrene/poly(vinylmethylether) samples prepared by Dr Han in collaboration with Dr Froelich.

Responsibilities for different aspects of the test programme have been assigned to:

Dr Partridge - mechanical tests
Prof Pastuska - thermodynamics
Prof Butta - morphological and dielectric properties
Prof Froelich - viscoelasticity in the solid state
Prof Prud'homme - melt rheology.

Dr Wurm will propose three zero-gravity tests for the European Space Laboratory.

The sixth annual NRCC/IMRI symposium on polymer blends was held on the two days following the meeting of the Working Party. The subjects spanned not only a wide range of scientific topics but also the economics of these increasingly important materials.

Technical Working Area

○ POLYMER COMPOSITES ○

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The last few years have seen a rapid growth in the application of composite materials in transport, building and anticorrosion fields and to some extent in aerospace. Basic standards on many aspects of glass fibre and carbon reinforced composites already exist but the rapid development of these materials requires much further work on standards for which international cooperation is attractive for reasons common to other VAMAS projects.

It should be emphasised that the novelty and internal structure of composite materials means that existing scientific and technical knowledge and practice are altogether insufficient to make standardisation easy.

Design methods or codes of practice are required that incorporate procedures for the analysis, presentation and use of data. The programme in this area comprises the evaluation of test methods of three basic kinds:

- Prediction of the lifetime of composite materials subjected to complex conditions.
  In practical use composite products are subjected to multiaxial steady or cyclic stress often in aggressive environments. Standardised tests are required to characterise mechanical behaviour under representative realistic conditions.
- Prediction of delamination.
  At present mechanical behaviour, whether under monotonic loading, fatigue or impact is characterised in most cases by the study of one basic damage phenomenon, namely interlaminar fracture. As compared with the investigation of metals, there is no precise specification for the test and analysis of interlaminar fracture. Fracture mechanics will be used to convert fracture data to parameters that adequately characterise the material.
- Non-destructive determination of damage.
  Non-destructive techniques are required to determine defects and damage in composite materials to assure the quality of structures and products. These techniques will make it possible to study and understand mechanisms of defect and damage generation and their effect on lifetime.

Experts in the VAMAS countries are consulting together to prepare specific contributions in these broad areas which will generate a constructive programme.

Technical Working Area

○ CERAMICS ○

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The CERAMICS programme of VAMAS concerns engineering ceramics and considers three topics: time dependence of strength and reliability, thermal shock resistance, and wear and friction properties.

Efficiency requires both a limitation of the number of topics to be studied and a sharing of the work between the partners. The main points are as follows:

- For reliability, the first activity will be an interlaboratory evaluation of test procedures for determining reliability parameters, using constant stressing-rate tests. The NBS will coordinate this topic in close cooperation with NPL. In Germany emphasis will be placed on non-destructive evaluation of mechanical damage.
- For thermal shock resistance, the favoured approach is likely to be the study of primary parameters (e.g. thermal conductivity) rather than complex parameters (e.g. thermal fatigue limit). Hence the proposal is to focus on such primary parameters, possibly including the use of reference materials.
- For wear and friction resistance, unanimity has been obtained for strong links with the WEAR TEST METHODS programme led by Prof Czichos. France has

already supplied alumina materials for this programme; other samples (silicon carbide, silicon nitride and zirconia) are expected by the end of 1985. Besides participating in the round robin exercises, where French tribologists and ceramists will work closely together, those in the ceramics programme will study the microstructural features of wear and friction, and the significance of hardness measurements as proposed by France, UK and Italy.

The programme on CERAMICS was further developed in May this year, when an opportunity for a meeting of many of the participants was offered by the Congress of the American Ceramic Society. A Japanese contribution is being sought.

Technical Working Area

○ HOT SALT CORROSION RESISTANCE ○

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Following the decision at the meeting of the Steering Committee in January 1985 to proceed with work in this area, a strategy for the programme has been agreed between the US and European participants and a contact has been established in Japan.

It is envisaged that the work will proceed in three stages. In the first phase information will be assembled on burner rig test conditions as a result of surveys carried out in North America and in Europe. Phase two will involve an intercomparison of test methods using a number of alloys and coatings under specified sets of conditions. The final phase will involve a complete statistical analysis and evaluation of the data generated in the intercomparison and, based on this information, a recommendation for a standard test procedure will be formulated. A detailed programme is being prepared for discussion between potential collaborators.

Technical Working Area

○ WELD CHARACTERISTICS ○

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This programme has two components: weld toughness and weld penetration.

Weld Toughness

The application of fitness for service criteria in assessing the integrity of welded structures requires an accurate knowledge of the effective weldment toughness. At present there is no reliable model for calculating the effective toughness from the geometry, stress pattern and localised properties; nor are methods for testing the weld as a whole available. However, before taking up this important subject and presenting it as a VAMAS project, steps are being taken to consider carefully the existing work carried out by the International Institute of Welding.

Weld Penetration

Work on the relationship between weld penetration and surface tension driven flow within the weld pool is now in progress in several centres in the UK, USA and Japan. The programme, details of which are being finalised, involves three main components, namely (i) measurements of the surface tension of liquid steel by various techniques, (ii) modelling of the metal flow conditions and the arc physics and (iii) welding trials. A revised programme will shortly be distributed and a meeting to coordinate the work is planned.

Technical Working Area

BIOENGINEERING MATERIALS

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It is well recognised that the performance of replacement materials used in the human body cannot simply be predicted from their properties in more normal environments. For example, the complex subject of rejection and the fact that bone adjusts itself to stress, place special requirements on materials and test methods.

The Technical Working Party met in June and its decisions on the topics to be covered will be presented in the next Bulletin.

Technical Working Area

SUPERCONDUCTING AND CRYOGENIC STRUCTURAL MATERIALS

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Superconductivity is characterised by the complete disappearance of electrical resistance at low temperatures enabling transmission of large electric currents and the generation of intense magnetic fields without energy consumption. Superconductivity provides the basis for advanced technological programmes involving superconducting generators, large scale accelerators, medical diagnosis by nuclear magnetic resonance, nuclear fusion reactors and ultra sensitive instruments. The establishment of standards on superconducting and cryogenic structural materials, both used together in the liquid helium temperature range, is now a key factor in the progress of these programmes.

The following topics have been put forward for cooperative action in the framework of international collaboration of VAMAS:

- Establishment of standard methods for measuring superconducting critical values, e.g. critical temperature, upper critical field and critical current.
- Standardisation of reference superconductors in order to clarify effects of component element purity and fabrication parameters on the superconducting performance.
- Establishment of standard methods for measuring a.c. losses and strain effects in superconductors.
- Establishment of standard methods of testing of mechanical properties, e.g. strength and toughness, of cryogenic structural materials in the liquid helium temperature range.
- Establishment of standard methods of testing of thermal, magnetic and electric properties of cryogenic structural materials in the liquid helium temperature range.
- Establishment of standard methods of testing of radiation effects on the performance of superconducting and cryogenic structural materials for the liquid helium temperature range.

The application of superconductivity is a new area of technology, so many of the projects mentioned above may need the development of new test methods. It is expected that international round robin tests will play an important part in many of these projects.

HIGH-TEMPERATURE MECHANICAL PROPERTIES

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Modern techniques for predicting the lifetime of components and the development of efficient methods of monitoring residual life have focussed attention on the need for accurate measurement of the growth rate of cracks originating from small defects in forgings and castings for high-temperature applications. Independent programmes are now in progress in Europe and in the USA to compare test procedures for determination of creep crack growth rates and there would be considerable potential benefit in harmonising this effort within the VAMAS framework. There is also strong interest in this topic in Japan. A preliminary meeting was held in the UK in June to formulate a plan of action.

OTHER TOPICS

EFFICIENT TEST PROCEDURES FOR POLYMER PROPERTIES

This topic was proposed by Dr F J Lockett of NPL. Test methods exist for measuring the engineering properties of polymeric materials. However, since these properties depend significantly on parameters such as time, frequency or rate of loading, temperature, service environment, processing route etc., complete property determination is a major task. This situation would be eased by the provision and validation of appropriate short-cut methods for data acquisition, based on interpolation, extrapolation, interconversion, accelerated testing, normalisation and optimised design of test specimens. Interest in this topic has been expressed by a number of Steering Committee members, who are consulting their national experts to develop a considered view.

FACTUAL MATERIALS DATABANKS

This topic was discussed at the January meeting of the VAMAS Steering Committee at which Mr H Kröckel of the CEC Joint Research Centre at Petten outlined the conclusions of the Workshop on Factual Materials Databanks held at Petten. There are close relationships between the development and the use of standard test methods and data:

- Databanks can provide a numerical input to the development of standards from a pool of data that can be updated.
- There is a common requirement for databanks and standards activities for identifying key parameters that can be used for characterising materials.
- There is also a common need for mathematical models that can be used to evaluate data, to extend spare data and to enable the calculation of materials behaviour in complex environments which may vary with time.

Although it might be premature to launch a VAMAS project on Factual Materials Databanks at this stage, Technical Working Parties were encouraged to use and develop databanks as an important means of advancing their aims.

MAJOR TEST FACILITIES

Certain types of major equipment for making measurements on materials are not available in all countries because of high capital and running costs. Thus one way in which VAMAS can contribute to international cooperation is by broadening the use of these facilities. As a first step it is intended to compile a database of facilities on which time is available and subsequently to consider ways to overcome organisational difficulties inherent in the use of equipment in other countries. To these ends Prof C Rizzuto of Italy (address below) is preparing a questionnaire for completion by operators of major test facilities.

• 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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Front Cover: Illustration of the advantages of using reference data in the calibration of X-ray photoelectron spectrometers.