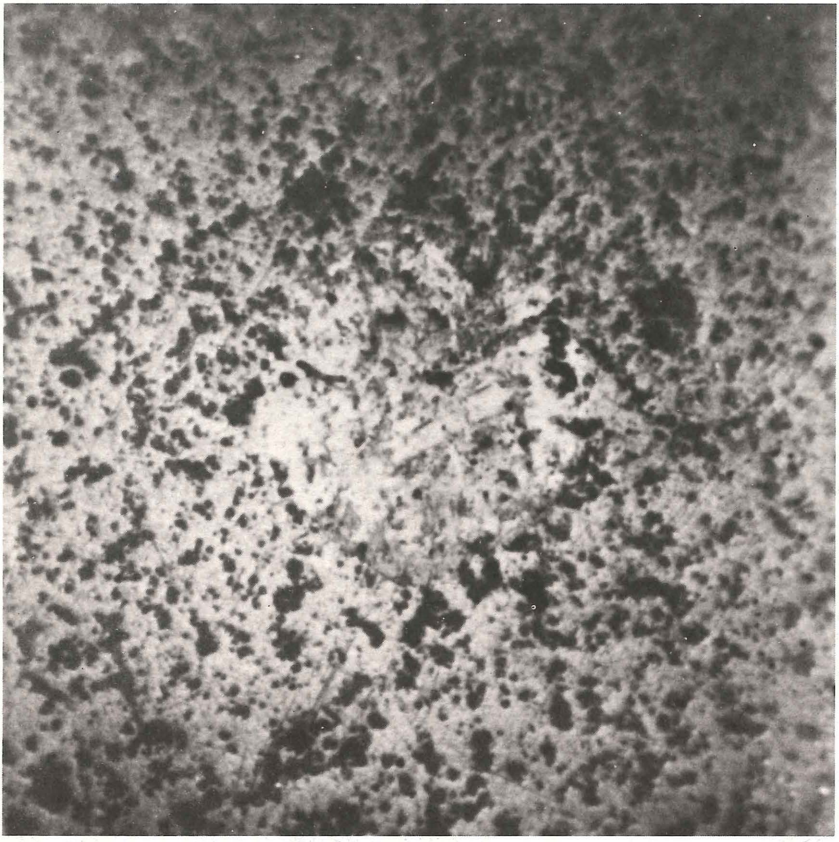
VAMAS



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January 1987

Versailles Project on Advanced Materials and Standards
Canada France Germany (FRG) Italy Japan UK USA CEC

VAMAS

MEMORANDUM OF UNDERSTANDING

At the recent meeting of the VAMAS Steering Committee in Tokyo, John Lockett, Alternate Chairman of the Committee, announced the imminent completion of the signing of the Memorandum of Understanding by all eight participants: Canada, France, Germany (FRG), Italy, Japan, the United Kingdom, the United States, and the European Communities.

This step will complete the foundation of an independent VAMAS. Begun under the aegis of the periodic Summit meetings of the Heads of Government as one of eighteen projects supporting Technology, Growth, and Employment, VAMAS will stand formally recognized by all participating governments as a unique contributor to the world economy, facilitating the incorporation of advanced materials in articles of international trade.

This recognition is a result in large measure of the early and continuing support provided by the National Physical Laboratory (NPL) of the United Kingdom. Throughout the process of the development of the "Understanding" incorporated in this Memorandum, NPL was at the helm in VAMAS. Critical guidance in this and other essential aspects of VAMAS operations was provided by the first Secretary of VAMAS, T.I. Barry, of that laboratory. Indeed, Dr. Barry and NPL founded this Bulletin and continue to provide invaluable assistance through their continuing role as publisher. With the completion of the signing of the Memorandum, VAMAS will once again be in Dr. Barry's debt.

Front cover:
Photograph of wear track in alumina disc (See story, page 3)

RESULTS OF THE VAMAS INTERLABORATORY STUDY ON WEAR TEST METHODS *

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INTRODUCTION

Very early in the VAMAS history, a technical working party was formed on wear test methods in order to conduct appropriate planning studies. The main objectives of the project were identified in the first meeting of the working party held in April 1985 in Vancouver, Canada, which involved 16 participants. These objectives were to organize and carry out an international comparison of wear and friction test data, using a well defined methodology with suitable advanced materials as specimens. As the first effort, measurement of the wear behavior of ceramics and inorganic coatings would be carried out in comparison with conventional materials. The multilaboratory interlaboratory comparison was begun in 1985 and focussed on the reproducibility of a sliding pin-on-disc friction and wear test. The West German Federal Institute for Materials Research and Testing (BAM) was asked by the VAMAS Steering Committee to organize, coordinate, and evaluate the comparison. This report summarizes the results of that comparison.[1]

PROCEDURES OF THE VAMAS INTERLABORATORY WEAR TEST COMPARISON

There is a general impression that absolute values of friction and wear found in laboratory experiments may differ considerably from test equipment to test equipment and from laboratory to laboratory. In contrast, for tribological tests performed in individual laboratories, good reproducibility has often been reported in the literature provided that the main governing factors are properly controlled.

In the 1960s an international cooperative program on the comparison of test methods on wear during sliding was performed by the Organization for Economic Cooperation and Development (OECD) Group on Wear of Engineering Materials.[2] For this study, different pairs of materials (copper, bronze, brass, steel) from a single batch were distributed to the participating institutions. The participants had to machine the specimens themselves with a surface roughness within a certain given range. The participants were allowed complete freedom in their choice of the type of test rig on which to perform the experiments; however, the test loads and speeds were specified. The results obtained in this comparison of test methods showed rather poor reproducibility.[3]

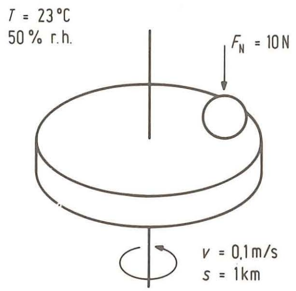
In view of the results of this OECD comparison, the conditions of the VAMAS Wear Test Study were carefully specified. A comprehensive list of test conditions was worked out by the Technical Working Party. For simplicity a ball-on-rotating disc specimen configuration was selected as the test system. The test specimens themselves were uniformly manufactured with respect to macro- and microgeometry and were in sufficient quantity for all laboratory participants. On the basis of a thorough systems analysis of the main relevant characteristics of tribo-testers,[4] a specific test plan was developed as described next.

* An abbreviated version of an article to appear in Wear (Cf. Ref. 1)

MATERIALS, TEST SYSTEM, AND MEASUREMENTS

Two materials were chosen for study: they were alpha-Al_2O_3 and AISI 52100 steel. The test system is shown schematically in Figure 1. It consists of a stationary ball (10 mm diameter) held against a horizontally rotating disc (40 mm outer diameter, 32 mm track diameter). The ball, disc, and wear debris were all to be collected after testing and protectively stored in plastic containers. The vibration amplitudes and frequency distribution of the test rig, and stiffness-data of the test rig were to be reported. The test environment specified was laboratory air, 50 ± 10% relative humidity, and a test temperature of 23 ± 1°C. No lubricant was used in the testing. The operating variables were continuous unidirectional sliding at a velocity of 0.1 m/s, a normal load of 10 N, a specimen temperature of 23 ± 1°C, a sliding distance of 1 km, and a specified number of replicate tests of 3 to 5.

Considerable attention was paid to the question of surface preparation of the test specimens. It was decided that the specimens would be used in the as-received condition by the participants. The surfaces would be cleaned immediately prior to each test by washing in freon, drying in warm air, rinsing with hexane, and drying in a drying oven at 110°C for 30 min. Measurements would be made to determine both friction and wear properties. Wear measurements would include wear depth, weight loss, wear scar diameter on ball, and profilograms of both disc and ball surfaces. Friction measurements would provide a graph giving friction force fluctuations. In addition, the wear surface and debris would be examined by optical and scanning electron microscope techniques. A detailed information sheet containing test and measurement instructions and specimen kits ready to be tested were sent from BAM to all participants.



Material pairings			Measurements
disc \ ball	steel	alumina	• Friction force
steel	kit 1	kit 2	• Wear (system, ball, disc)
alumina	kit 3	kit 4	• Wear surfaces (SEM, profilometry)

FIGURE 1. Sliding wear test system with specified parameters noted; test materials and desired measurements are listed.

TABLE 1. Country and Laboratory Participants

Canada
- Ontario Hydro Research, Toronto, (P. E. Dale)
- National Research Council, Mechanical Research Department, Vancouver, (H. M. Hawthorne)
- National Research Council, Industrial Materials Research Institute, Canada, (J. Masounave)

Federal Republic of Germany
- Bundesanstalt für Materialforschung und -prüfung, Berlin, (H. Czichos)
- Technische Hochschule Darmstadt, (E. Broszeit)
- Technische Universität Berlin, (H. G. Feller)
- Robert Bosch GmbH, Stuttgart, (H. Schorr)

France
- Ecole Nationale Supérieure de Céramique Industrielle, Limoges, (P. Boch)
- Ecole Centrale de Lyon, (Ph. Kapsa)
- Hydromécanique et Frottement, Andrezieux-Bouthon, (J. L. Polti)
- Institut National des Sciences Appliquées, Villeurbanne, (M. Godet)
- Valeo, St. Ouen, France, (D. Mnard)

Great Britain
- University of Leeds, (D. Dowson)
- Brunel University, Uxbridge, (T. S. Eyre)
- National Physical Laboratory, Teddington, (E. A. Almond)
- University of Bradford, (T. H. C. Childs)

Italy
- University of Pisa, (R. Bassani)
- CISE, Milano, (R. Martinella)
- Istituto per le Ricerche di Tecnologia Meccanica, Vico Canavese, (G. Tipatti)

Japan
- Mechanical Engineering Laboratory, Ibaraki, (Y. Enomoto)
- Government Industrial Research Institute, Osaka, (M. Iwasa)
- National Aerospace Laboratory, Tokyo, (M. Nishimura)

United States of America
- National Bureau of Standards, Gaithersburg, MD, (A. W. Ruff)
- National Bureau of Standards, Gaithersburg, MD, (S. Hsu)
- Eastman Kodak, Rochester, NY, (K. Budinski)
- EXXON Research and Engineering Co., Annandale, NJ, (T. E. Fischer)
- Sohio Engineered Materials Co., Niagra Falls, NY, (S. G. Seshadri)
- Corning Glass Works, Corning, NY, (J. W. Adams)
- GTE Laboratories Inc., Waltham, MA, (S. Wayne)
- Georgia Institute of Technology, Atlanta, GA, (W. Winer)
- Oak Ridge National Laboratory, Oak Ridge, TN, (C. Yust)

RESULTS

A total of 31 institutions participated (see Table 1). The experimental results were sent by the participants to BAM for evaluation and compilation.

Friction and Wear Data

Four types of data were analyzed using the reports of the participating laboratories: (1) the friction coefficient determined after 1000 m sliding distance; (2) the linear wear rate of the system under steady state conditions, defined as the displacement of the test specimens perpendicular to the sliding interface between 300 and 1000 m sliding distance divided by the sliding distance difference (Note that this is a geometry-dependent quantity which cannot be compared directly with wear rates of other test geometries.); (3) the ball wear scar diameter; and (4) the disc wear track width.

In order to evaluate the friction and wear data properly, the results of the participating laboratories were treated as follows: (1) results only of laboratories which have performed more than one test run per specimen kit were considered: (2) if laboratories have reported only average values (as estimated by themselves from repeated test runs) these have been treated as if obtained from three measurements; (3) outlier values have been eliminated if they are either outside the range of 3 standard deviations, or not fulfilling the Dixon-test.

From these data, mean values and standard deviations for the different material pairings were calculated. The coefficient of friction values obtained by the participating laboratories are shown in Figure 2 and Table 2. The mean value and scatter band are shown for all values reported for steel sliding against steel. These results are quite similar to those obtained in a single laboratory over a long time period involving many tests. They reflect the effect of a number of variables on the friction coefficient in such a system. The friction values for the other three material kits also are given in Table 2. Further analysis (using ASTM standard E691) has shown that the reproducibility of friction in the entire study was:

- **friction**
  within laboratories: ±9 to ±13%
  between laboratories: ±18 to ±20%

The mean values and standard deviation for linear wear and wear scars size on both ball and disc specimens are also shown in Table 2. The reproducibility of the wear data was analyzed as follows:

- **system wear**
  within laboratories: ±14%
  between laboratories: ±29 to ±38%
- **specimen wear**
  within laboratories: ±5 to ±7%
  between laboratories: ±15 to ±20%

These within-laboratory reproducibility ranges are very consistent with experience at both BAM and NBS. The between laboratory results are also consistent with those from ASTM interlaboratory comparisons associated with particular wear test standards.[5]

TABLE 2. Mean Values and Standard Deviations of Friction and Wear Data

ball / disc	steel / steel	ceramic / steel	steel / ceramic	ceramic / ceramic
Coefficient of friction[1]	0.60 ± 0.11	0.76 ± 0.14	0.60 ± 0.12	0.41 ± 0.08
number of data	109	75	64	76
number of labs.	26	26	23	26
Wear rate of system [m/km][2]	70 ± 20	very small	81 ± 29	very small
number of data	47		29	
number of labs.	11		11	
Ball wear scar diameter [mm]	2.11 ± 0.27	2.08 ± 0.35		0.3 ± 0.05
number of data	102	[3]	60	56
number of labs.	23		21	19
Disc wear track width [mm]		0.64 ± 0.13		not measured
number of data	[4]	54	[4]	
number of labs.		19		

NOTES:
1) at 1000 m sliding distance
2) determined from the wear curve (steady state range between 300 and 1000 m sliding distance)
3) material transfer from disc to ball
4) material transfer from ball to disc

materials: AISI 52100 steel, α-Al_2O_3 ceramic
test conditions: F_N=10N, v=0.1m/s, T=23°C, r.h. 12-78%

Wear Surfaces

The wear patterns occurring in dry sliding of the four material pairings can be summarized as follows:

- **steel ball/steel disc:** Adhesive shearing, material transfer from ball to disc and tribooxidation of the steel
- **ceramic ball/steel disc:** Abrasion, grooving of the disc, materials transfer to the ball and tribooxidation of the steel
- **steel ball/ceramic disc:** Severe abrasion of the ball, material transfer to the disc and tribooxidation of the steel
- **ceramic ball/ceramic disc:** Slight abrasion of the ball and slight smoothing of the disc surface.

Some characteristic pictures obtained from wear surfaces at BAM are shown in Figures 3 and 4 and on the cover. Figure 3 shows the worn steel disc surface of the ceramic/steel pairing. A groove on the steel disc is shown in the photograph and the profile tracing of that groove indicates the wear depth. For the ceramic/ceramic pairing little wear occurred on either the disc and the ball. Figure 4 shows the change in the surface appearance of the ceramic ball as well as the profile tracing used to determine the depth of wear.

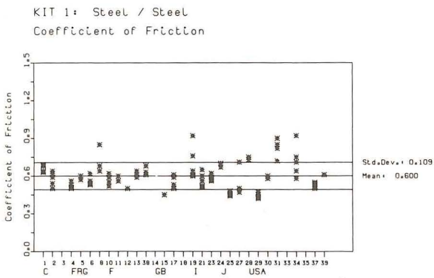


FIGURE 2. Friction coefficient results from 26 laboratories for steel ball sliding on steel disc.

CONCLUSIONS

Interlaboratory Measurements

The results of the first round of the VAMAS wear test comparison show that good within laboratory and between laboratory reproducibility of the friction and wear data has been obtained. This is believed to have resulted largely from the close control specified and realized by the participants on the test parameters of load, speed, and ambient temperature. However, the relative humidity of the ambient atmosphere, was reported to vary between 13% to 78%, outside of the specified range of 50 ± 10%. In fact, there appears to have been a tendency for a decrease in wear with increasing relative humidity.

Standardization Requirements in Tribotesting

This study illustrates that specification and control of certain tribological quantities leads to superior results in comparative tests. The geometry of the stationary and moving specimen and the wear track dimension were specified. The chemical composition, microstructure, hardness, and surface roughness were controlled. The chemical nature and relative humidity of the test environment were known. The type of motion, load, sliding velocity, temperature, and sliding distance were all controlled. Cleaning procedures were defined. Finally, the tribological quantities to be measured, e.g. specimen wear or system wear, and the choice of wear dimension (e.g. length, mass or volume) were made clear.

Implications of these Tribotesting Results on the VAMAS Program

This interlaboratory study is the first one completed under the VAMAS program. It has been successful in several important respects. The participants represented seven of the VAMAS countries, and also a high proportion of the leading tribology laboratories in the world. The study examined both a reference grade metallic material and an advanced ceramic material. The friction and wear data obtained on these two materials showed a high degree of reproducibility among the measuring laboratories. The importance of close control of several parameters during testing was demonstrated. These results should permit future standardization of the test method used here. They also provide baseline data for friction and wear properties of two materials that designers of tribological systems may use. Future interlaboratory testing in this and other working groups can build on the experience gained here, and thereby provide even more valuable contributions to material science.

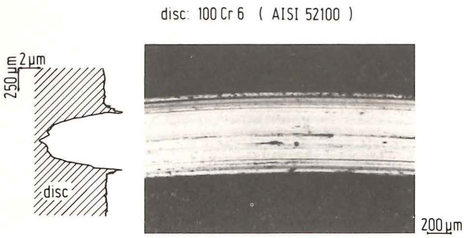


FIGURE 3. Photograph of wear track on steel disc, and corresponding profile measurements.

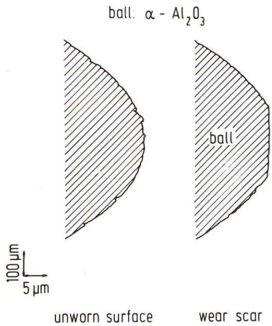


FIGURE 4. Profile measurement of alumina ball.

Acknowledgements

We appreciate the provision of the alumina samples by the Compagnie Industrielle des Céramiques Electroniques (CICE). Thanks are due to P. Boch, Ecole Normale Supérieure de Céramique Industrielle, Limoges, for his help and to all the participants of this international endeavour for their diligence in carrying out the specified measurement program.

(1) H. Czichos, S. Becker, and J. Lexow, "Multilaboratory Tribotesting: Results from the VAMAS Program on Wear Test Methods," *Wear* **114,** (1987), p. 109-130.

(2) A. Begelinger and A.W.J. de Gee, "Synopsis of the results from an international cooperative wear program" *Lubr. Engng.* **26** (1970), p. 56-63.

(3) A.W.J. de Gee, "Review of the activities of the OECD Group of Experts on Wear of Engineering Materials," TNO Nieuws. **21** (1966), p. 302-308.

(4) H. Czichos, "Tribology—A systems approach to the science and technology of friction, lubrication and wear," (Elsevier, Amsterdam 1978).

(5) ASTM Committee G2 Research Reports on Standard G-77 and G-83 (ASTM, Philadelphia, PA).

• TECHNICAL WORKING AREAS •

Technical Working Area 1

WEAR TEST METHODS

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In order to obtain reliable information on the comparability of wear test methods, the working group started with a round robin exercise including AISI 52100 (steel) and alpha alumina ceramics. Both were tested in a ball on disc configuration in all four possible combinations: steel ball/steel disc; alumina ball/steel disc; steel ball/alumina disc; and alumina ball/alumina disc. A complete set of samples was sent to 36 participating laboratories in Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. By the end of August 1986, results have been returned by 30 laboratories.

On the basis of the results compiled, the first round robin is considered to be a full success. It has been proven that the reproducibility of friction and wear measurements is as good as the reproducibility of measurements of other engineering quantities provided that the tribological conditions are well defined.

A second VAMAS wear round robin is being planned. Silicon carbide and silicon nitride are under consideration. Discussions are under way concerning the specific operating conditions.

Technical Working Area 2

SURFACE CHEMICAL ANALYSIS

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Surface chemical analyses are now 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 optimization, 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 and so that measurements and information can be reliably transferred from one laboratory to another.

The principal objective of this Working Party is to produce by coordinated effort the reference procedures, reference data, and reference materials necessary to establish standards for surface chemical analysis. The status of projects initiated in 1985 is as follows:

- **Development of thin oxide films as reference materials.** Work is nearing completion between laboratories in the UK, France, Canada, and Belgium to define the accuracies of different methods for determining the atomic thickness of a tantalum pentoxide on tantalum material developed earlier in the UK. The material is available with two oxide thicknesses and will be useful as standards for calibrating ion-beam fluxes in sputtering experiments and in high-energy ion-beam reaction and scattering experiments.

- **Development of calibration data for the energy scales of Auger-electron spectrometers.** Traceable calibrations have been established in the UK for Cu, Ag, and Au Auger peaks with an accuracy of $\pm$ 0.02 eV. Similar but independent measurements are nearing completion in the US.

- **Procedures for quantitative x-ray photoelectron spectroscopy.** Test materials prepared in Canada and Germany have been identified as candidates for a proposed round robin on measurements of film thickness and film stoichiometry. A round robin will be designed following test measurements in the US.

Additional multilateral projects are expected to be initiated following a meeting of national representatives in London on November 17, 1986. Some of the topics under consideration for such projects are: correction methods for backscattering in Auger-electron spectroscopy (AES); measurements of spatial resolution in AES; tests of algorithms and software for data processing; tests of channeling effects in AES; development of reference materials prepared by ion implantation; and development of reference materials for the measurement of depth resolution in depth-profile analysis.

Two workshops on quantitative surface analysis with this Working Party as a co-sponsor were held in the autumn of 1986. The first was held at NBS on October 24 and the second at NPL on November 17. Each workshop preceded a major international meeting and had discussions on reference data, reference materials, reference procedures, and instrument calibration.

An article on objectives, plans and projects of the Working Party was published recently in *Surface and Interface Analysis* [**9,** 79-83 (1986)]

Technical Working Area 3

CERAMICS

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Two intercomparisons are underway: 1) the determination of environmentally enhanced fracture, led by Stephen Freiman and Edwin Fuller of NBS, and 2) the determination of hardness, led by Roger Morrell of NPL.

A number of laboratories in the U.S. and Britain who wish to participate in the fracture test series have been identified. Aluminum oxide specimens for the interlaboratory test procedure have been received from Desmarquest and have been distributed to participants.

The hardness test round robin is progressing well. NPL has characterized and distributed 25 pairs of alumina ceramic samples, one each to France, Italy, Germany, the US, and the EC; six to Japan, and the remainder in the UK. The return date is the end of 1986. Analysis of the results is expected to be complete by mid 1987.

Technical Working Area 4

POLYMER BLENDS

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Polycarbonate/polyethylene (PC/PE) samples for a round robin of mechanical and structural testing have been distributed to all participating countries. Preliminary tests have already been made in several countries.

Rheological characterization in the solid and molten states has been carried out in Canada, France, and the UK. Thermal analysis and accelerated aging tests have been performed in Germany. Morphological studies have been carried out in Italy, the UK, and Canada. Infrared spectroscopic measurements have been performed in Germany. Dielectric measurements have been made in Italy and the UK. Interfacial properties also have been examined in the UK. As a result of high viscosity of PC and PE at 285°C, determination of the interfacial tension proved to be impossible. After 24 hours, equilibrium shape had not been obtained. However using lower viscosity analogues, the interfacial tension was calculated to be 7.8 mN per meter. The value for the VAMAS blends was estimated to be 8 to 9 mN per meter.

Problems were encountered with the initial flatness of the samples, which was insufficient for several of the tests. A procedure developed independently in the UK and in Canada to flatten the samples has been applied successfully and work is proceeding satisfactorily.

Over the next year the results will be compared and analyzed, and the test procedures modified and repeated.

The next meeting of the TWP-Polymer Blends is scheduled for Bundesanstalt für Materialforschung und -prüfung (BAM) in Berlin on April 13 and 14. For hotel reservations please contact Prof. Dr. G. Pastuska at BAM before the beginning of the new year.

Technical Working Area 5

POLYMER COMPOSITES

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Delamination tests of composite materials are useful for the determination of the tenacity of the matrix. This depends on interface rupture by crack growth, a function of the interface properties. Application of fracture mechanics concepts seems to be a promising method to study delamination of composite materials.

Work in ASTM D 30.02.02 has addressed the accuracy of testing in this area. The need for a satisfactory method for the determination of those properties linked to delamination is now widely recognized.

A VAMAS round robin is being designed to assist in the resolution of these problems. ASTM is working with the delamination of carbon fiber composites under constant loading. Therefore, VAMAS will begin with fiber glass composites, first under constant loading, and then extend this to cyclic loading.

Two types of materials are being supplied by Vetrotex: a unidirectional epoxy fiber glass material and a woven fiber material. A principal goal in the study is to prove that the dissipated energy rate during delamination is a satisfactory measure of the toughness of resins under certain conditions. These conditions need to be determined. The following parameters will be studied: specimen size, delamination initiation, test control, and means of extension.

Technical Working Area 6

SUPERCONDUCTING AND CRYOGENIC STRUCTURAL MATERIALS

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This Technical Working Party had its first meeting at the Karlsruhe Nuclear Research Center on April 28 and 29, 1986. The meeting was attended by 19 participants of summit countries and two non-Summit countries, Austria and the Netherlands. In addition, there were some invited technical specialists.

At this meeting, the current status of research programs in participant countries and that of related international cooperation were reported. It was then agreed to institute a comprehensive round robin test to measure the critical current of Nb_3Sn superconductors. A firm time schedule for this round robin was drafted. Later series of measurements, covering AC losses in superconductors and the tensile strength and fracture toughness of cryogenic structural materials, were also agreed to at this meeting.

The critical current, I_c, is the most important parameter in practical high-field superconductors. CEC will provide tantalum-doped improved Nb_3Sn conductors for the round robin test, while Japan will provide titanium-doped samples. The possible provision of samples from the US has not been decided. These standard samples were dispatched in September, 1986, to 26 participating laboratories.

A questionnaire on the methods and existing test equipment for AC loss measurement in superconductors, based on proposals at the first TWP meeting by Prof. van de Klundert of the Netherlands, has been distributed. A questionnaire on existing test equipment to be used for the round robin test of cryogenic structural materials is being constructed by Dr. R. P. Reed of the US.

An intermediate meeting took place at the time of the 1986 Applied Superconductivity Conference in Baltimore. Reports on the progress of the I_c round robin test were made, and discussions on future collaboration in AC loss measurement and cryogenic structural materials round robin tests took place there. The I_c round robin measurement of Nb_3Sn superconductors will be completed by the end of March, 1987. The second TWP meeting is scheduled on June 22 and 23, 1987 at the National Bureau of Standards in Boulder.

Technical Working Area 7

BIOENGINEERING MATERIALS

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During the first meeting of the Technical Working Party in Capri, Italy, in conjunction with the IUPAC meeting on blood-materials interactions in June 1985, the activity of the Working Party was divided into four areas, according to the materials environment:

1) materials in contact with hard tissues
2) materials in contact with soft tissues
3) materials in contact with blood
4) materials for biotechnology

The second meeting of the Technical Working Party was held in Chester, UK, in March 1986 in conjunction with the "Consensus Conference on Definitions in Biomaterials," sponsored by the European Society for Biomaterials.

During this meeting, two programs were selected:

A) Intercomparison of Implantation Tests Involving Different Cell Cultures, under the leadership of Dr. G. Heimke of Germany

B) Controlled Study of Synthetic Materials with Blood Plasma Proteins and Monoclonal Antibodies, under the leadership of Prof. Marcel Josefowicz

Subsequently, a cooperative project between Japan and Italy was officially submitted, under the auspices of VAMAS, for funding by the two governments. It is expected that the agreement will become fully operative in 1987. Responsible for the initiative are Dr. T. Tateishi of MITI and Dr. D. De Rossi of the University of Pisa. The initiative refers to a joint study on Critical Issues Related to the Design and manufacturing of Advanced Materials for Prostheses and Artificial Organs.

Consideration is being given to a similar agreement to support extension to the British scientific partners of the Technical Working Party, through negotiations with Prof. D. F. Williams.

Technical Working Area 8

HOT SALT CORROSION RESISTANCE

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Materials used in critical "hot-end" applications in gas turbines, e.g. blades and nozzle guide-vans (NGVs) are required to have adequate resistance to hot salt corrosion. This is particularly important in engines used in industrial and marine environments where atmospheric pollution (e.g. NaCl content) and impurities in the fuel, particularly sodium and sulphur, can combine to cause serious problems of corrosion. Various test techniques have been developed to assess the hot-salt corrosion resistance of these alloys, which are usually Ni-Cr- or Co-Cr-based; but there can be considerable inconsistency in the results obtained with individual alloys in different test conditions.

In recent years there has been an extensive international effort aimed at understanding the hot-salt corrosion mechanism and the relevance of the various test techniques in terms of the operation experience with engine components. As a result, there is now some general agreement about the mechanisms of corrosion in these conditions and some consensus regarding the parameters to be controlled in order to establish valid testing procedures.

The aim of the VAMAS effort is to build on these developments by bringing together relevant organizations in Europe, the US, and Japan to define an agreed set of testing parameters for rig tests and subsequently to carry out an intercomparison to confirm the validity of the procedures used. This would then provide an agreed database from which national and international standards could be developed.

The work has progressed to the stage where a survey of testing conditions in rig facilities has been completed and plans for an intercomparison exercise to be conducted using agreed guidelines with specified test parameters are being finalized. It is expected that the guideline document will subsequently be modified to serve as a code of practice for this type of testing.

Technical Working Area 9

WELD CHARACTERISTICS

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A detailed program is being developed in weld pool penetration in conjunction with chemical analysis. Among the projects under consideration is an intercomparison.

Technical Working Area 10

MATERIALS DATABANKS

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This program is designed to identify standardization activity related to the computerization of material property data. The Working Party is defining as precisely as possible all standards needed to build materials data systems, whether centralized on mainframes or stored on local or personal computers. The thrust is to identify problem areas and options for addressing these problems. A report will be issued in Spring, 1987. The outline of this report is:

Recommendations and Conclusions

1. Introduction—the Need for Standards
2. Data Collection
3. Database Building, including Data Analysis
4. Access to Data
5. Computer-Integrated Engineering and Expert Systems
6. Organizations Active in Materials Data Standards

Attention will be devoted to the user community.

Technical Working Area 11

CREEP CRACK GROWTH

Dr. T. B. Gibbons, NPL, Teddington, Middlesex, TW11 OLW
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Small cracks induced during welding or by corrosion or fatigue can form in components operating at high temperatures and may grow under steady load (i.e. creep). The rate of crack growth in these circumstances is an important parameter and can be particularly significant in the estimation of residual life in steam power plants, for example. Currently there is no agreed and standardized method for measuring creep crack growth; various designs of specimens and measuring techniques are used, depending largely on the experience of different laboratories. Furthermore the choice of appropriate correlating parameters to relate laboratory measurements to component behavior is a topic of some controversy.

Independent groups in the US, Europe, and Japan have recognized the need to standardize testing procedures; intercomparisons have been organized by ASTM E-24, the European Group on Fracture (EGF) Task Group 1, and the Japanese Committee for the Promotion of Science. The aim has been to examine the influence of various testing parameters on crack growth measurements and to assess interlaboratory reproducibility of data obtained under defined conditions. VAMAS work links these various activities and others so that intercomparisons can be assessed within a wider framework and a compatible body of technical data produced. This will provide the basis for the development of national and international standards in techniques of creep crack growth measurement and evaluation.

Technical Working Area 12

EFFICIENT TEST PROCEDURES FOR POLYMER PROPERTIES

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This new project is concentrating on two areas:

1) accelerated durability tests for polymers exposed to conditions of heat, light, and/or humidity

2) correlation between time, temperature, and stress, etc, to provide reliable acceleration of tests or extrapolation of data

The initial efforts consist of 1) a comparison and evaluation of existing methodologies for accelerated durability tests, and 2) a review of correlation procedures and assessment of their future potential. Planning of the contents of two reports is well advanced, and contributions from VAMAS participants are being discussed. The proposed time scale seeks completion of the reports during 1987, including identification of recommendations for further experimental work (for example, round robin tests, scientific examination of mechanisms) for consideration.

Tentatively Approved
Technical Working Area 13

LOW CYCLE FATIGUE

Dr. David Gould, CEC, rue de la Loi 200, B-1049, Bruxelles
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Adequate low cycle fatigue tests simulating in-service conditions are difficult to devise and perform, expensive to execute and frequently give conflicting results. They, however, remain essential if the safe operation of parts occasionally stressed into the plastic region is to be ensured without the high costs, disruptions to services and duplication of facilities associated with frequent preventative maintenance.

The aim of this project is to examine the effect of variables, such as specimen shape and size, extensometer type and failure criteria, upon the results of low cycle fatigue testing. This activity, initiated by the European Community and extended via VAMAS, currently involves 18 European and 6 Japanese laboratories testing 4 materials, namely IN 718, 9Cr1Mo (strain softening), AISI 316L (strain hardening) and Nimonic 101 (strain stable).

• VAMAS Calendar •

Technical Working Party Reports due for Steering Committee	18 Mar 87
Agenda available for Steering Committee meeting in Pisa	1 Apr 87
Polymer Blends Technical Working Party meeting in Berlin	13-14 Apr 87
Steering Committee Meeting in Pisa	13-15 May 87
Workshop on Creep Crack Growth in France	June 87
Superconducting and Cryogenic Structural Materials Technical Working Party meeting in Boulder	22-23 June 87
Polymer Composite Technical Working Party Meeting in London, in conjunction with the International Conference on Composite Materials	21 July 87
Meeting on Creep Crack Growth in Dourdan, in conjunction with the International Seminar on High Temperature Fracture	16 Oct 87

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