

ESIS Executive Report

During the ESIS Council meeting in Poitiers last September, Dr. Ian Milne presented his report to the Council for the period of September 1994 till September 1996. In Poitiers, Prof. Dominique François was elected as the ESIS President for the period 1996 till 2000. Further details about the Poitiers meeting, including details of the changes in ESIS policy, as already mentioned by Dr. Milne in his report below will be given in detail in the next Newsletter.

Report 1994-1996

This is the last report which I as your president, with my executive advisers, will be making. During the four years of my period of office, it has become apparent to me that ESIS is facing a challenging future precipitated partly by our expansion among countries in Eastern and Central Europe, and partly by the structural changes within both the west and the east. These cultural changes are affecting the way we work and communicate, and are putting quite a strain on our collective and individual resources. Other organisations, like ASTM, operate as commercial enterprises, while we in ESIS have traditionally operated as a gentlemen's club. I believe that it is vital to retain aspects of the gentlemen's club atmosphere, but it is equally vital to ensure the security of our future. This revolves around the membership, our technical committees and their meetings, our influence at national and international level, and the quality of our publications. Most importantly, is our income. Apart from finances needed to run the administration, we also proved help for travel to meetings, and for other things. I shall deal with each of these items in turn.

Membership

Our membership comprises 304 individual members and 20 organisational members and sponsors. In addition, the newsletter is sent to about 1700 individuals who we regard as postal members. These individuals give no financial payment to ESIS, although they are free to take advantage of the ESIS organisation other than the financial discount which we have

arranged with our publishers. The cost of sending the newsletter to the non-paying members is born by ESIS. Since the membership fee at Dfl. 60 is not onerous I see no reason why more recipients of the newsletter should not become paid-up members. A drive to increase this level of membership will be mounted at ECF 11.

It is worth observing that if half of these postal members paid the modest membership fee we would receive a substantial amount per year, comparable to our income from book publications in a good year.

Technical Committees and Influence

The areas covered by the technical committees has increased over the last 2 years, with the incorporation of the High Temperature Mechanical Testing Committee as TC 11, and the birth of new sub-committees. You will read about these in the reports from the respective TC chairmen. At the last meeting of the council, action was placed upon me to reinstate activity in TC 2. Many TC chairman felt that they had a number of potential activities which would be better addressed under the subject of 'Micromechanisms' rather than within their own TCs. Despite this feeling, I was unable to obtain much in the way of proposals from these TCs, and regretfully, decided to leave TC2 dormant for the present. I reported this through the newsletter. TC1 had already taken action to develop a sub committee activity of their own in this respect, and I suggested that other TCs might follow TC1's lead. Once some of these activities start to overlap, a proper focus

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would be developed to resurrect TC2, and also joint meetings could be held.

Following the agreement of the Council in 1994, I have also agreed an association with the Federation of European Materials Societies, FEMS. The objective here is to help avoid duplication, proliferation and confusion over structural integrity issues, and to raise our profile within the material's community who sadly remain in ignorance of our existence. As part of this exercise I wrote an article for the journal *Euromaterials* which outlined the history, objectives and role of ESIS. ESIS continues to have influence in the standards scene, through the activities of our TCs in drafting guidelines and standards which are eventually taken up by CEN or ISO.

Publications

These are particularly important to ESIS, being one of our key objectives and also our major source of income. We operate in a competitive environment, where the technology is rapidly changing, and we have to keep our product both cost-effective and high in quality. We are indeed fortunate in having the international journal *Fatigue and Fracture of Engineering Materials and Structures* as our official journal. This prestigious journal is not only of the highest standard, but it provides members with copies at a generous discount and provides a good financial contribution to ESIS annually. It is important that everyone supports it as much as possible.

The publications chairman reports on our publications record separately. The number of publications now stands at 20 (no 21 is in pipeline as I write). These have all been published under an agreement with MEP. This agreement runs out in September. Over much of the past year I have therefore been engaged in activities to secure a new agreement which will provide an increase in sales, a decrease in price, improved advantages for members through discounts, and with it, an improved income for ESIS. At the same time, we have had to recognise the technological changes which are not only present now, but which will arrive during the period of any new contract; the development of the internet, CD-ROM etc. At the last meeting of the council, I was under instruction to ensure that the quality of production was also maintained, by if possible, retaining type setting as the means of printing.

I am pleased to announce the new publishing agreement which is with Elsevier. This has been agreed following full consultation with the Executive, with the present chairman of the publications committee, and with other senior members of ESIS, and meets all the objectives we set. It has been drawn up with generous discounts for members, to encourage postal members become full members. It takes full advantage of new technology, by using CRC printing, but safeguards quality by requiring copy to be furnished on disk (which allows editing to a standard format) and retyping where needed, up to 10% of the total number of pages. To keep the price reasonable we have set the standard book size at

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Production	
ESIS Office	
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400 pages, and the target retail price is £150 at 1996 prices. The new agreement provides for the following:

- Personal copies of special publications to paid-up ESIS members only at discounts of 25%.
- Authors and delegates at ESIS meetings 40% discount based upon an optional purchase.
- Where the price of a special publication is built in to the meeting registration fee, a separate price to be negotiated which will be no greater than 50% of the regular published price.
- A maximum of 4 free copies for editors and the ESIS secretariat.
- Via the internet, free access to ESIS members to Structural Integrity Alert, which includes useful information like journal contents, etc.
- Via the ESIS office, subject to a bulk purchase of 250 minimum, 70% discounts on the journals Engineering Fracture Mechanics, International Journal of fatigue, Engineering Failure Analysis.

Other non-financial advantages of the contract are:

- Provision for Elsevier to take over publication and circulation of the newsletter to members at no charge to ESIS. Within this, is a proposal to charge non-members (i.e. the postal members) a nominal fee which will cover the costs. The intention is to encourage membership and so maximise the sale of discounted books and other

services, without reducing the service to non-members. This is a change from tradition, which will certainly be debated at the Council meeting.

- Provision to organise and provide other support for the ECF series of conferences, where agreed with the local organising committee. This provision does not need voting on, as it is available for organisers at their discretion. The services will include full financial liability for the conference, venue research and negotiation, catering and social programme, budgeting and accounting, marketing and publicity, and other administration. This will be especially valuable to those organisers who are embarking on major conferences for the first time. It also includes publication of the ECF proceedings.

Elsevier will also pay a royalty to ESIS on net income received from the sales of the Special Publications, in addition to the discounts to individual purchasers. It is therefore clearly within our interest to organise ourselves to gain the best advantage. For this purpose, we have set a target of 2 to 4 books per year, the same as under the old agreement. To ensure that we meet this target, and that we have an even frequency of publications throughout the years, I am attempting to set up a publications strategy, based on each TC producing at least one Special Publication every 3 years. The intention is to spread the publication list more evenly across the 11 TCs (at present 2 TCs are responsible for 65% of our publications) and to give TCs something to aim for. I have asked

all TC chairman to help in the development of this plan.

This is a historic agreement, and if we can make it effective, it offers many advantages to ESIS. In particular, it will help secure our finances for years to come, and help reduce our demands on goodwill and voluntary contributions. It will also provide us with capability of professionalising parts of our services and administration where these are needed, and provide us with more money to help with travel for those who have difficulty in raising the funds. Because of the importance of it, and because of its link to be used to increase our membership, Elsevier and ESIS are performing a marketing exercise at ECF I, at which we hope to improve our membership dramatically. Prior to the Council adopting this report, I would like them to debate the detail of the publications strategy, and to give guidance on the proposal to charge a nominal fee for postal members to receive the newsletter.

Closure

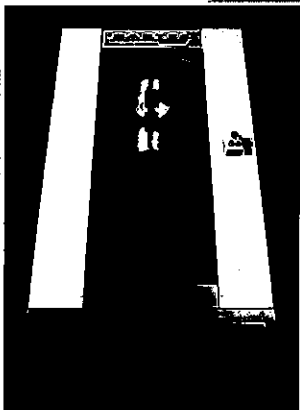
I would like to close by advising you that I am stepping down after 4 years in office, which I have enjoyed immensely. I would like to thank all those who have supported me in those four years. In particular, I wish to thank my executive advisers, who have diligently put up with endless requests for advice, some of my closest friends in ESIS, Keith Miller, Dominique Francois, Karl Schwalbe, the publications committee chairman Don McDiarmid, the TC Chairmen, and of course last but probably the most, Ad Bakker. ESIS is in good hands with people like these as members.

I. Milne
President 1992-94

A fresh approach to materials testing



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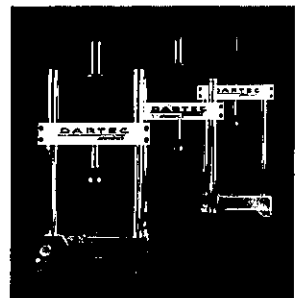
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ESIS TC5 Subcommittee on Dynamic Testing at Intermediate Strain-Rates

Minutes of meeting held at the Fraunhofer Institute, Freiburg, April 18-19, 1996.

Introduction

The ESIS TC5 Subcommittee on Dynamic Testing at Intermediate Strain-Rates met at the Freiburg Institute, Freiburg on Thursday and Friday, 18th and 19th April 1996. This meeting was in part sponsored by three testing machine manufacturers, HKE (Ettlingen), Roell-Amsler (Gottmadingen) and Russenberger/RUMUL (Neuhausen/CH). These companies also provided an exhibition of their products and services, which added greatly to the interest of the meeting, which was chaired by Mr. H. MacGillivray (Imperial College) and attended by 30 participants. We were blessed with fine Spring weather, and on Thursday evening after the

meeting was adjourned, we enjoyed an excellent meal at the Greiffeneggsschlossle restaurant on the hill overlooking Freiburg, with fine views of the vineyards and the Black Forest.

Dr. Bohme welcomed everyone to IWM Freiburg, and thanked the sponsoring companies for their support. He then spoke briefly about the DVM group and its work and relationship to ESIS. Professor H. Blumenauer (Magdeburg) then delivered a short presentation reviewing 70 years of Instrumented Impact Testing.

Progress was reviewed under the following headings:

1. Miniaturised Charpy-V standard.

Dr. Lucon reported on the status of the work, quickly reviewing the Phase 1 round robin, and the production of the Draft Standard, of which Draft 4 is the latest version. Phase 2 testing is now in progress, with participating labs. being free to follow their interests. A one-day meeting could be held to discuss these results when they are all in. The group will also contribute to the ASTM meeting in January 1997. Enrico Lucon presented the results which are available so far, pointing up the major trends in behaviour which have become apparent. He discussed his own results from CISE in more detail. Professor Kalthoff and Dr. Bohme then presented their results. The importance was stressed of defining how $F_{0.2}$ is measured, and Dr. Lucon agreed to include the method into his next draft. Thursday's meeting was adjourned at this point.

2. Dynamic R-Curve Round Robin.

H. MacGillivray briefly reviewed the background to the dynamic R-curve round robin based on one structural steel. He presented the relevant J-R curves, plotted using data processed by Dr. Lenkey, and invited others to join the programme. V. Mentl (Skoda) and F. Loibnegger (T.U. Vienna) indicated that they wished to join the next round robin.

3. Instrumented Charpy-V Standard.

Professor J. Kalthoff reported on the ISO meeting in Paris in November 1995, at which our proposed Standard on Instrumented Charpy-V Testing was considered. Written comments had been received from Japan, U.S.A. and France; these were also considered, and the ISO prepared a Committee Document, copies of which were circulated by Professor Kalthoff, together with a summary of the (mainly minor) changes made. The Committee Document will next be considered at the ISO meeting in Madrid in June, and we can be pleased with the results of the Paris meeting. Dr. van Walle expressed reservations regarding the ISO tup/ASTM tup agreement; there are problems with the ASTM tup. Mr. MacGillivray thanked Professor Kalthoff for his efforts in Paris on our behalf.

4. Dynamic Compression Testing.

A. Doig (RMCS, Shrivenham) ran through the proposal tabled at the last meeting. We could take a static testing standard and write in new material for dynamic conditions. The problem with compression

testing is the friction effects at the test-piece end faces. Also, as compression proceeds, the strain-rate decreases, eventually to zero. We could follow the ASTM E9-81 standard approach using a fixed length/dia. ratios. It was agreed that we include both approaches in our initial draft standard, and then run a round robin. Five members indicated an interest in taking part.

5. Dynamic Tensile Testing.

A. Klenk (MPA Stuttgart) spoke, reminding members of our draft standard, which is similar from 7 institutions have been obtained from a round robin. Mr. Schule (MPA Stuttgart) had evaluated the results, which he went on to present. Yield Strength, U.T.S., Elongation after Fracture and Reduction of Area were all plotted against Plastic Strain Rate. The ensuing discussion ranged over determination of the yield point, dynamic effects and taking account of the damping built into most test methods. Dr. Klenk appealed for any further data or comments to be sent by the end of June, so that final drafts of both

the report and the Draft Standard can be produced by Autumn 1996.

6. Instrumented Pre-cracked Charpy Standard.

Mr. MacGillivray reviewed the background to Draft 5 of the document, which was then discussed in detail, paragraph by paragraph. The discussion had reached Paragraph 7 when time ran out; it was agreed that we re-commence discussion at paragraph 8 at our next meeting. Any comments on this draft should be sent to Mr. MacGillivray, who will re-draft the document before the next meeting.

Next Meeting

The sub-committee will next meet at Poitiers during the ECF-11 conference, to be held from 3 to 6 September 1996. Mr. MacGillivray closed the meeting, thanking Dr. Bohme and his colleagues for organising an excellent meeting, these thanks were echoed by all participants.

John L. Sturges, Secretary, ESIS TC5 Subcommittee.

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Recently published titles from the EUROPEAN STRUCTURAL INTEGRITY SOCIETY (ESIS) **MULTIAXIAL FATIGUE AND DESIGN (ESIS 21)**

Edited by A Pineau, G Cailletaud and T C Lindley

A valuable collection of thirty-two papers presented at the fourth international conference on Biaxial/Multi-axial Fatigue held in Saint-Germain en Laye, France. The papers focus on the important aspects of biaxial and multi-axial fatigue research including experimental testing methods; laws for the cyclic behaviour of materials; fatigue damage models and methodologies in design and integrity assessment. A number of papers are particularly concerned with multi-axial fatigue aspects in design in the automotive industry.

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Edited by E van Walle

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Edited by J G Williams and A Pavan

An important collection of thirty-nine reviewed and revised papers presented at the ESIS European Symposium which took place in Sardinia, Italy.

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ESIS Technical Committee 10 on
Environmentally Assisted Cracking
and Subcommittee on
Hydrogen Degradation

Minutes of 6th Workshop Meeting held at Rez, Czech Republic, 13-14 May 1996 on
Fracture Mechanics Approach to Corrosion Assisted Cracking

The sixth ESIS TC 10 workshop meeting on "Fracture Mechanics Approach to Corrosion Assisted Cracking" was held at the Nuclear Research Institute (NRI) in Rez (near Prague), Czech Republic. It was the second time to organise such a meeting by NRI and it was also the first joint meeting of TC 10 and the new Subcommittee on Hydrogen Degradation which was formed at the ICM7 at The Hague.

Because of the large number of contributions which were due to be presented, the meeting was scheduled for two days, 13th and 14th May, 1996, in order to have sufficient time for discussion. On the first day the meeting was started at 8.30 Hrs. with the welcome address of Dr. Jan Kysela, Head, Reactor Services Division, NRI, and a brief introduction of the activities of the Materials Integrity Division of NRI by Dr. Martin Ruscak. On the second day the meeting was declared closed at 13.00 Hrs.

In the three technical sessions there were 14 presentations which covered various aspects of environmentally assisted cracking (EAC) and degradation of materials in the presence of hydrogen. The following papers were presented during the course of the meeting:

Technical session I:

Research and Testing of Environmentally Assisted Cracking

- A. Brozova, M. Ruscak, E. Keilova (CR): Comparison of SCC mechanisms of two bainitic steels through CT and tensile specimens testing
- V. Panasyuk and I. D. Dmytrakh (UA): Corrosion fracture mechanics of structural metals: the role of localised electrochemical processes between deformed material and environment
- Ph. Tipping (CH): Basic requirements for research on EAC in nuclear power plant materials
- H. M. Nykyforchyn (UA): Peculiarities of mechanical factor effect on stress corrosion cracking in structural steels
- K. Matocha, J. Wozniak (CR): Mechanisms of fatigue crack growth in water environment

Technical session II:

Research and Testing of Environmentally Assisted Cracking (contd.)

- M. Ruscak, P. Chvatal, E. Keilova, P. Sajdl (CR): The crack growth in the cladding and undercladding materials of the VVER pressure vessel under cyclic loading

- J. Stolarz (FR): Fatigue and corrosion fatigue mechanisms in highly pure Nickel and Ni-Cr-Fe alloys
- C. Rinaldi (IT): Residual life extension of an economizer header
- N. Edwards (IT): Current knowledge of crack tip chemistry
- J. Ruiz (ES): Results of tensile test on hydrogen embrittled steels
- G. Gabetta (IT), H. M. Nykyforchyn (UA), and W. Dietzel (DE): TC 10 affairs

Technical Session III:

Aspects of hydrogen degradation

- O. Ye. Andreykiv, H. M. Nykyforchyn (UA): Hydrogen degradation of structural materials: Problems of structural integrity and some solution methods
- A. Griffiths (UK): Hydrogen uptake and cracking in duplex stainless steels under galvanic coupling conditions
- V. S. Ratchuk, N. S. Goncharov, M. A. Rudis, V. I. Kholodny, S. G. Valykhov (RU): Material selection and some questions on the component reliability for the development of liquid hydrogen-oxygen rocket engines

- Y. Katz (Israel): Some complexities in deformation/corrosion interactions
- V. Fishgoit, V. A. Kolachev (RU): Procedure of hydrogen tests in aerospace industry
- H. M. Nykyforchyn (UA): Application of fracture mechanics approaches to evaluation of high-temperature degradation of structural steels

On the first day the main topic of discussion was the development and assessment of fracture mechanics test methods for EAC and their validity. It appeared important to the participants that TC 10 should intensify investigations in this area with special emphasis on dynamic test methods such as the rising load or rising displacement K_{ISCC} tests. The importance of choosing suitable loading/displacement rates for these tests was illustrated by the results presented by various speakers. With respect to the ongoing joint European research project in which more than 20 members of TC 10 are involved and which aims at improving fracture mechanics based EAC test methods, it was proposed that future round robin tests and collaborations should include more people working in different organisations and industries, specifically the nuclear industry.

Another topic of discussion was what importance the cracking mechanisms should be given by this committee. Some of the participants were more interested to know the effects of relevant environmental and mechanical parameters and to find countermeasures to prevent EAC, while others argued that the knowledge of the underlying mechanisms of EAC should be of primary interest. Copies of the guidelines for terminology and nomenclature in the field of structural integrity formulated by Prof. D. François were distributed to the participants with the request to forward their valuable comments to the chairpersons as soon as possible so that they can be included in the discussion at the forthcoming ECF II.

The second day was mainly devoted to works related to hydrogen degradation of materials as a special subject of the newly formed Subcommittee. The objectives of this Subcommittee were illustrated by Prof. Andreykiv from Ukraine, who is one of the chairmen of the Subcommittee. Persons who were interested to join this Subcommittee were requested

to inform Prof. Andreykiv to that effect. Prof. Andreykiv proposed to publish the papers presented in this workshop in a special issue of the journal "Physico-Chemical Mechanics of Materials" of the Ukrainian Academy of Sciences. The authors were requested to send their papers to Prof. Andreykiv for review and publication.

The activities of this Subcommittee yet remained to be completely specified, which are mainly oriented towards methodologies at present. Suggestions are welcome to give various directions to these activities. One suggestion was to start common projects. One proposal for such a project has recently been submitted by Wolfgang Dietzel for the INCO-Copernicus Programme of the European Commission. This project is supposed to include three laboratories from Central and Eastern Europe and two from EU member states.

37 participants from 12 countries took part in this workshop. It was the highest number of participants experienced so far in these series of meetings. For the first time the number of participants from Central and Eastern European countries exceeded that of representatives coming from Western European states, indicating that the integration of the scientists from those countries into the ESIS is really making a good progress. Many participants expressed that they have enjoyed the open minded and relaxed discussions and the spirit of cooperation which was a characteristic feature of this workshop. A good deal of this was due to the unique location of the place of meeting and the perfect organisation of the same by the Czech hosts.

It has been decided that the next workshop meeting would be held at *Milano, Italy, in September 1997*. Giovanna Gabetta will organise this meeting, presumably with the cooperation of the colleagues from the same region of Italy (SNAM, CISE). It has also been decided that a meeting subsequent to the one mentioned above would be arranged at Lviv in Ukraine, most likely in September 1998.

Giovanna Gabetta
Wolfgang Dietzel

FATIGUE & FRACTURE of ENGINEERING MATERIALS & STRUCTURES

The International Journal

Editor-in-Chief: K. J. Miller

The official journal of



the European Structural Integrity Society

VOLUME 20 (1997)
12 Issues

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FURTHER DETAILS OF VOLUME 20 (1997)

Name of Journal	FATIGUE AND FRACTURE OF ENGINEERING MATERIALS AND STRUCTURES
ISSN	8756-758 X
Frequency	12 Issues per year
Cost of Volume 20	£580
Agency Notes	SIRIUS is not a commercial / business publishing house. Its major aim is the gathering, storing and world-wide dissemination of knowledge on Structural Integrity matters at the lowest possible cost. No agency fee is therefore included in the price quoted above. Agencies may wish to collect their fees directly from their clients.
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Note:-	All articles published will be peer-reviewed by a minimum of two, frequently three, and sometimes four, experts in the field selected from the international research community concerned with the fatigue and fracture of engineering materials and structures.

This international journal emanates from the office of:

The Structural Integrity Research Institute of the University of Sheffield

ECF - 12

European Conference on Fracture 1998
University of Sheffield, England
Monday 14 September to Friday 18 September 1998,
Ranmoor House, Shore Lane, Sheffield, UK

INTRODUCTION

The conference sessions and technical/scientific presentations will be built around the structure of the Technical Committees (TC's) of ESIS listed overleaf and so delegates will be asked to nominate which particular session(s) they wish to be affiliated to in terms of both their possible scientific paper contribution and possible future ESIS participation.

12 One major aim of the conference will be to consolidate the ESIS Technical Committee structure and to make any necessary modifications that will enhance collaboration with other similar international organisations (eg: ASTM) to the mutual advantage of all concerned.

Another major aim of the conference will be to provide a format that facilitates the continued and successful growth of the various publications of ESIS, following the new policy constructed by our outgoing President, Dr Ian Milne, and endorsed by our new President, Professor Dominique François.

A final major aim will be to ensure a conference environment that assists international, interdisciplinary research on fracture problems via sessions for scientific presentations, technical discussion groups and new developments in instrumentation, codes of practice and standards.

FURTHER INFORMATION

Periodical updates on the progress of the ECF - 12 organisation will be continually announced in the ESIS Newsletter and the ESIS international journal: Fatigue and Fracture of Engineering Materials and Structures; the latter being published monthly.

CONTINUITY OF ECF EVENTS

ECF-11 in Poitiers will provide the background data base to ensure a smooth transition to ECF - 12 in Sheffield and the Chairmen of EC11 will be honorary members of the ECF - 12 organisation.

Continued overleaf

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TEAR OFF SLIP

I am interested in being provided with further information on ECF - 12 and wish to be added to the circulation list. In particular:

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I wish to be a member of the Review Panel for submitted papers relating to:

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REVIEWING PANELS

All submissions will be reviewed for possible publication in the conference proceedings. The major effort of reviewing papers will be conducted by the 27 members of the SIRIUS Board of Editors of the international journal of Fatigue and Fracture of Engineering Materials and Structures (FFEMS) assisted by the various Chairmen and members of the ESIS Technical Committees.

THE TECHNICAL COMMITTEES OF ESIS

The Technical Committees of ESIS, plus their current sub-committees are:-

TC1.0

Elastic-Plastic Fracture Mechanics

TC1.1

R-curves and Tearing Instability

TC1.2

Fracture Mechanics Testing Standards

TC1.3

Local Approach

TC2.0

Micromechanisms

TC2.1

Stretch Zone Studies

TC2.2

Micro-cleavage fracture

TC3.0

Fatigue

TC3.1

Multiaxial Fatigue

TC3.2

Contact Fatigue

TC4.0

Polymers and Composites

TC5.0

Fracture Dynamics

TC5.1

Crack Arrest

TC5.2

Impact Testing (Conventional)

TC5.3

Impact Testing (High Rate)

TC6.0

Ceramics

TC7.0

Nomenclature

TC8.0

Numerical Methods

TC8.1

Elastic-Plastic Fracture & Creep

TC8.2

Constitutive Modelling

TC9.0

Concrete

TC10.0

Environmental Assisted Cracking

TC11.0

High Temperature Mechanical Testing

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Address for return of the tear-off slip overleaf

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ESIS Technical Committee 6 on Ceramics

Minutes of the 11th meeting
20th and 21st of May, in Barcelona, Spain

The 11th meeting, in Barcelona, was hosted by Prof. Anglada of the "Escola Tècnica Superior d'Enginyers Industrials de Barcelona (ETSEIB)", which is a school of the "Universitat Politècnica de Catalunya". There were 16 participants from 7 countries and 9 presentations were made, leading to intensive discussion. The main subject area covered by this meeting was "Fatigue and Fatigue Effects in Ceramic Materials". A number of presentations were also made as addenda to the discussion of the results of the Round Robin exercise on fracture Toughness Testing. Abstracts of the presentations are given below. It was decided that a new co-operative project between the working groups of this committee should be started and possible themes and sources of funding should be investigated well in advance of the next (12th) meeting. This will be hosted by Dr. Jan Dusza of the Slovak Academy of Sciences, in Slovakia.

Abstracts

Mechanical Fatigue in Monolithic Non-Transforming Ceramics - A Review

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Five years ago Ritchie and Dauskardt presented their state of the art of fatigue research on ceramics.

While the basic findings still apply today, the considerable amount of new test data and modelling efforts has provided deeper insight in the underlying micro-mechanisms. In this review the micro-mechanisms associated with fatigue effects in monolithic non-transforming ceramics are reviewed and classified.

The fatigue effect refers to the difference in lifetime observed between fatigue and static loading conditions. At room temperature the fatigue effect is negligible for materials which fail transgranularly, where as a negative effect occurs in materials with intergranular failure modes.

Various mechanisms contribute to accelerating crack growth in room temperature fatigue. Due to the flushing action of the repetitive opening and closing of the crack the effect of an aggressive environment on crack growth, which is highly dependent on the characteristics of the intergranular phase, can be aggravated. Residual microstresses which lead to crack arrest under a static load, may combine with reversed cyclic stresses to reactivate the crack. Local residual tensile stresses generated as the result of the formation of a damage zone at the crack tip in

the compressive half of the cycle will enhance crack growth as well. This effect sets a limit to the load bearing capacity of notched ceramic components under compressive fatigue loading, and it reduces their residual tensile strength. The positive effect of energy absorbing mechanisms that resist crack growth during the crack opening phase is countered by crack reactivation during unloading. Microcracks are initiated as the result of the wedging action of crack wake asperities which force the crack tip to remain open during unloading. The crack growth acceleration associated with the crack wake asperity effect is most pronounced at low crack propagation rates in ceramics of moderate toughness. In the case of ceramics which show R-curve behaviour the negative fatigue effect primarily results from the gradual deterioration of crack wake bridging features. It is anticipated that the fatigue mechanisms operating at low temperatures will cause a more pronounced effect with the advent of tougher ceramics with more tortuous crack wakes. Whereas at low temperature the fatigue effect is cycle dependent i.e. related to the number of crack opening / closure events, frequency dependent phenomena determine the fatigue effect at high temperature. Specifically, the effect of fatigue loading at high temperature is controlled by the amount and viscosity of the grain boundary phase. When an amorphous grain boundary phase is present the mechanical behaviour and the damage susceptibility of the ceramic become very strain rate sensitive. Room temperature fatigue mechanisms which cause

the crack growth rate to increase relative to that under static loading, tend to be suppressed at high temperatures because of the overriding potential of the intergranular phase to accommodate morphological mismatches due to its low viscosity. Instead, effects such as crack healing, damping and viscous crack bridging contribute to prolong the fatigue lifetime compared to the lifetime under static loads.

Visco-Elastic Energy Dissipation in Silicon Nitride under Uniaxial High Temperature Fatigue

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With a high precision, high temperature uniaxial testing facility the stress-strain behaviour in tension-compression cyclic load-controlled tests was carefully examined for a silicon nitride ceramic. The partial glassy grain boundary phase induces an opening of the stress-strain loop, the area of which is a measure of the dissipated energy. The temperature, frequency and stress amplitude dependencies of the measured energy dissipation have been investigated. The results indicate that the energy dissipation becomes more important at higher temperatures and stress amplitudes, and at decreasing frequencies. The energy dissipation per time unit increases with test frequency. It can hence explain the longer lifetimes observed under cyclic loading compared to those under static loading reported in literature.

Subcritical Crack Growth and Thresholds in a 3Y-TZP Ceramic under Static and Cyclic Loading Conditions

J. Chevalier, C. Olagnon, G. Fantozzi

GEMPPN, INSA Lyon, France

Crack propagation behaviour of a 3Y-TZP ceramic has been investigated under static and cyclic loading by means of the double torsion method (DT). Static fatigue has been measured in air, in oil and in water at different temperatures for two grain sizes in order to understand the contributions of the various propagation mechanisms. Stress corrosion by water and transformation toughening seem to play the major contributions, but crack bridging has also been observed. A typical $V-K_I$ curve with three stages and a threshold is obtained in air.

A crack accelerating effect is shown under cyclic loading, correlated with a decrease in the threshold value. The role of R (defined as the ratio of the minimal to maximal stress intensity factor, K_{Imin} and K_{Imax} respectively) and K_{Imax} has been investigated. A modified Paris law has been shown to fit the data above the threshold.

The effect of cyclic fatigue has been attributed to shielding degradation. Both degradation of transformation toughening and crack bridging could explain the cyclic crack accelerating effect.

Indentation Fatigue of some Silicon Nitride based Ceramics

Beáta Ballóková, Pavol Hvizdos, Ján Dusza

Institute of Materials Research, Slovak Academy of Sciences, Kosice, Slovakia

Three silicon nitride based ceramics, prepared using UBE-E10 silicon nitride powder with 4.6wt.% of Al_2O_3 and 3.4wt.% Y_2O_3 as a sintering additives, were used for experiments: a monolithic Si_3N_4 , a composite $Si_3N_4 + SiC$ -nano-particles prepared by adding of 10 wt.% of amorphous Si-N-C powder to the basic mixture, and a $Si_3N_4 + SiC$ -platelets composite with 20 wt.% of SiC platelets.

The indentation test was carried out by indenting repeatedly onto the same point of the specimen surface by using a Vickers indenter. The applied load was in the range of 100N to 350N. Holding time of each indentation was 1s and the intervals between indents approx. 3s. The number of cycles to chipping was detected during the test procedure. After the performed indentation test the radial crack length and the size of the chipped out area were measured using optical and SEM microscopes.

Results showed that the nano-composite system exhibited the longest life-time (the greatest number of cycles to chipping) at the individual loading forces. This tendency is more evident for lower applied loads. The $Si_3N_4 + SiC$ -pl. composite seems to be the most sensitive one concerning the indentation load value and exhibits the shortest life-time.

From the relation between the size of chipped out area and indentation load it is evident that in the case of lower loads interval the largest chipping area at the individual applied loads was found in the case of monolithic Si_3N_4 , while in higher loads interval the monolithic and nano-composite systems exhibited a similar behaviour. The $Si_3N_4 + SiC$ -pl. composite

exhibited the lowest chipping areas in the whole investigated load interval.

The study of the lateral crack growth rate S/N revealed that in high loads interval the difference between the monolithic and nano-composite systems was negligible, but in low loads interval the nano-composite system showed evidently lower lateral crack growth rates. The $\text{Si}_3\text{N}_4 + \text{SiC-pl.}$ composite exhibited the lowest lateral crack growth rates in the whole investigated load interval.

Microfractography of the chipped area revealed that the dominant fracture mechanism in all studied ceramics is intergranular fracture.

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Toughening Development with Surface and Through Thickness Cracks in Y-TZP: Indentation Precracking Effects and Correlation between Fracture Mechanics and Strength Evaluations

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Universitat Politècnica de Catalunya, Barcelona 08028, Spain

R-curve evaluations with indentation cracks are compared to those of ideally semielliptical surface cracks; the differences are associated with the indentation crack shape of Y-TZP. Crack growth experiments assess the influence of loading rate on the crack growth behaviour under monotonic loads. The results are mainly related to the development of slow crack growth effects. The influence of crack geometry on R-curve evaluations is studied with through thickness and semielliptical surface cracks. A simple geometrical parameter, which seems to be related to the increase in toughening with crack extension, is used in such an assessment. Finally, the fatigue and static life limits and failure strength are correlated with fracture mechanics evaluations under cyclic, static and monotonic loading.

Mechanical Properties Measurement at the ICV

M. Isabel Osendi

Institut de Ceràmica y Vidrio, CSIC
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A summary of the experimental techniques used at the Ceramics Dept. of ICV for the mechanical

characterization of technical ceramics will be presented. Description will be focused on fracture toughness, strength, elastic modulus and fatigue measurements of oxide and non-oxide ceramics. Some works to be presented have been performed entirely at the ICV and others, in collaboration with different groups. Special attention will be paid to the influence of the temperature on the mechanical behaviour of ceramics and some examples for different materials studied in the department will be given.

Cyclic Fatigue Degradation in Crack Bridging Ceramics

F. Guiu and Ming Li

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The ceramic materials which are capable of developing crack bridging are also found to be susceptible of cyclic fatigue degradation. This effect is usually explained as being due to the degradation of the strength of the bridging ligaments by the cyclic loads. A model which seems to have been widely accepted proposes that this bridging degradation is produced the frictional wear of the bridging ligaments under the repeated sliding of grain interfaces over a large number of cycles. This model is critically re-examined and it is argued that it should be rejected as a credible explanation of the cyclic fatigue effects observed in some monolithic ceramics.

Based on a series of experimental results and microscopical observations, it is proposed that the degradation of the bridging ligaments under cyclic loads is not produced by frictional processes but results from the rupture of mechanically locked asperities and unbroken grains during the load reversals. The effect of load reversals is that of helping to break the strongest ligaments, always present near the crack tip, or helping to extend the microcracked zone near the crack tip.

Sharp Notches for Fracture Toughness Testing

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A notch-size dependence in Single Edge Notch Bend-Saw cut (SENB-S) fracture toughness testing is

frequently observed. A theoretically based relationship to explain this is presented. It is shown that the SENB-S method gives valid results for five-grained, low porosity materials only if the notches made are of the size of the relevant microstructural features. A simple method to make consistent fine notches of tip diameter of less than 10 μm is presented. The results of fracture tests with very fine notches, on the same materials as that of a previous ESIS TC6 Round Robin, are compared with the results of that Round Robin. Agreement with predicted values according to the presented relationship is shown to be good.

Influence of Phase ASSEMBLAGE on the Relative Static to Cyclic Fatigue of Zirconia Ceramics

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Spain*

The susceptibility of transformation-toughened materials to strength degradation due to both environmental effects and cyclic loading is already well-known. However, such susceptibility seems to be very different for materials with different phase assemblages.

In the present study an extended investigation has been performed to compare the effects of different microstructural and chemical parameters on relative static to cyclic fatigue behaviour of zirconia ceramics. The materials studied include fine-grained yttria-stabilized tetragonal polycrystalline-zirconia (Y-TZP), coarse-grained magnesia-partially stabilised zirconia (Mg-PSZ), both under peak-aged and eutectoid-aged conditions, and zirconia toughened alumina (ZTA) containing different volume fractions of zirconia particles. Except for the eutectoid-aged Mg-PSZ, in all the materials the tetragonal zirconia was contained within a matrix material of different structure, i.e. tetragonal zirconia itself in the Y-TZP, cubic zirconia in the Mg-PSZ and alumina in the ZTAs. A detailed examination of the microstructural characteristics, the fatigue life and fatigue crack propagation behaviours, and the fatigue and fracture mechanisms for each of those materials has been conducted. Testing has been performed under constant (static) and cyclic loading, and the latter at different load

ratios such to evaluate relative static to cyclic behaviour.

The experimental results indicated that, although all the materials showed a real cyclic fatigue effect, the Y-TZP and the ZTAs are much more sensitive to static fatigue, as expected, than the Mg-PSZs and the alumina respectively. Within the Mg-PSZs, the static to cyclic fatigue behaviour of the eutectoid-aged material is less pronounced than that found for the peak-aged material. The results are discussed in terms of the intrinsic susceptibility to environmental effects of the physical scenario associated with dominant crack-microstructure interaction in each material. Hence, microcracking, either around the transformed particles as a consequence of mechanically induced phase transformation or along grain boundaries from thermally induced microstructural changes, plays a more or less important role in accelerating the degradation process, depending upon the surrounding matrix and its local chemistry.

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Closure

The meeting was concluded with a guided tour of the facilities of the ETSEIB, Universitat Politècnica de Catalunya. The chairmen wish to thank all the participants and especially Prof. Dr. Anglada for the smooth and successful running of the meeting. The provisional dates agreed for the **next meeting**, to be hosted in the region of Bratislava, Slovakia (near Vienna, Austria) by Dr. J. Dusza of the Slovak Academy of Sciences, are the

3rd and 4th of April 1997.

**Prof. Dr. R. Danzer
Dr. M. Steen**

Polymers and Composites

Meeting 22-24th May 1996 - Les Diablerets, Switzerland

The Eurotel in Les Diablerets was again the venue for another successful meeting of the ESIS Technical Committee 4 on Polymers and Composites, chaired jointly by Professors Williams and Pavan. The twenty people who attended were treated to a newly refurbished conference room and some very high quality discussions and presentations.

18 The first day started with a presentation by Dr. Moore on the revised protocol for the determination of K_{Ic} and G_c for injection moulded short fibre composites, which was sent out to participants last April. There then followed some discussion on the issues of pop-in failure, the use of P_{max} for crack initiation and the size criteria. It was concluded that, although there are still some issues in the protocol which are not rigorous, the document is a sensible compromise. There will now be a one year break from round robins and protocol development, to give participants an opportunity to acquire more field experience and enable a scientific paper to be written. During the second session, consideration was given to the impact J protocol and the session was led by Professor Williams who covered for Mr. MacGillivray, who was attending an ASTM meeting in Florida. It was noted that the protocol was in need of expansion as there were some ambiguities in the text. There then followed a series of presentations on tests on ABS and HDPE. A discussion on how to fit the data led to the observation that fitting a power law to the data was no more satisfactory than drawing the blunting line, and then a linear fit to the other data. There is still some data to come in, and this should be forwarded to Hugo MacGillivray along with any comments about revisions to the protocol. Anybody wanting more supplies of HDPE should contact Dr. Clutton (BP Chemicals).

A summary written by Dr. Hale (TWI) on the current status of the J testing of plastics was then distributed in his absence. Dr. Hale intends to submit a paper on this protocol to a scientific journal and proposes the International Journal of Fracture, but would welcome other suggestions. There was again discussion as to whether the data should be fitted to a power law with the $J_{0.2}$ value quoted, or whether the blunting line should be drawn with this value of J quoted. No agreement was reached and clearly this subject will be returned to next time. After lunch, Professor Pavan presented modifications to the protocol for impact testing at less than 1 m/s. An Excel programme is now available from Professor Pavan (Politecnico di Milano) for curve fitting the data. Previous round robins had been run on PVC and ABS. However, the results for ABS were non linear and hence the seven data presentations concentrated on PVC. The results presented indicated reasonable agreement between the values of G_c and K_{Ic} measured by the different groups. It was concluded that the protocol now worked well and Professor Pavan recommended that an additional round robin be conducted using rubber modified PMMA. Discus-

sion of the greater than 1 m/s test was limited due to the absence of Dr. Böhme, but it is hoped that he will be able to attend in October.

The second day started with an update on the current status of the mode I laminates protocol presented by Dr. Brunner. The mode I ESIS document was submitted to ISO in January 96, after a number of ASTM recommendations had been implemented. It was then decided by ISO that the US should submit a draft Committee Document to ISO, based on the ESIS document. It was reported that at an informal meeting between the ASTM, ESIS and JIS during ECCM7 in London recently, the Japanese put forward a list of 26 comments, 9 which they described as major, relating to the draft document, version 96-01-29 which was prepared by Dr. O'Brien of ASTM. (For a detailed list of these comments, please contact Dr. Brunner at EMPA). We are currently waiting for the revised version of this document, which will appear after a French translation has been made. Dr. Brunner then stressed that we must co-ordinate our response to the Japanese comments in time for the ISO meeting in September 96. Could all those involved in the laminates work stay in contact via e-mail, and forward comments to either Dr. Davies (Ifremer) or Dr. Brunner.

The mixed mode testing of laminates was then discussed and Dr. Brunner reported that although no round robin activities had been planned for 95/96, an ISO compatible draft of the ESIS AD/GB document was available. However, progress on this depended on decisions to be taken on mode II. Dr. Blackman then reviewed an ASTM round robin on the MMB test, in which Imperial College had participated. The modified NASA rig had been used. There was then discussion about whether such a wide range of mixed-mode G values were actually required by industry. Professor Cervenka (Shell, Amsterdam) argued that a single mixed-mode value of G was insufficient to characterise a material and that the MMB test should be pursued. Five groups said that they would be interested in participating in a round robin using the MMB test, and the details of this will be agreed upon in the next meeting. Other groups wishing to participate should contact Dr. Blackman (Imperial College).

The current status of the mode II test in use, with ESIS pursuing the ELS test, ASTM pursuing the ENF test and JIS favouring a stabilised version of the ENF test. (Anyone wanting details of the stabilised ENF test should refer to the Hojo paper in Composites, Volume 26, Number 4 1995 pp 257-267). A joint round robin has been set up by VAMAS on mode II, in which two groups from each of

ESIS, ASTM and JIS will perform all three tests. This round robin will commence shortly, with Imperial College and Ifremer / EMPA participating for ESIS. A presentation was then given by Dr. Blackman detailing some initial stabilised ENF tests which were performed at Imperial College. The latest ESIS round robin results on precracking prior to ELS testing were then presented and it was concluded that the wedge precracking procedure (favoured by JIS) needed to be modified to avoid introducing damage to the crack tip. Dr. Brunner agreed to make this revision.

Cross ply laminate testing was then reviewed by Dr. Blackman. This is to be a new ESIS venture. There has been an offer from Hexel (UK) to provide fabric prepreg for a round robin, and nine groups signed up to participate in this. It was suggested that the ISO mode I document be used as a starting point for these tests, and hence details of this round robin will be circulated at the next meeting. Anyone further who wants to participate should contact Dr. Blackman.

We then returned to our discussions on the Essential Work of Fracture. Dr. Clutton (BP Chemicals) gave a review of all the test results to-date. The statistical aspects of this test continue to cause concern, and Professor Williams asked each group if they would choose a minimum, middle and maximum ligament length, and then do ten repeat tests at each of the three ligaments and from these data, deduce the intercept, w_0 . It is hoped that these data can be presented at the next meeting, after which all the data will be passed on to a statistician for further analysis. The trace coalescence method was abandoned, due to the lack of exact similarity between the traces. The day ended with a presentation by Professor Williams on statistical problems.

The final day started with Professor Pavan reporting a financial summary of the last ESIS run conference in Sardinia. Attention was drawn to the very high cost of

producing the published volume of conference papers. There was then a discussion on the venue / data / title / scope and format of the next ESIS conference to be held during 1998. Professor Pavan proposed two possible venues in Italy (beside Lake Como or Lake Garda) and agreed to obtain costings for these two options in time for the next meeting. Professor Williams suggested the possibility of holding the meeting in Les Diablerets, and Professor Cervenka agreed to look into the Swiss option more closely, preparing a costing in time for the next meeting.

We then moved on to discuss the new protocol for adhesives testing which was written by Professor Kinloch (Imperial College). Professor Williams briefly outlined the main features of the document and gave details of the forthcoming round robin. Details of this will be sent out to the groups who signed up at the meeting last October. The issue of the high cost of specimen manufacture was raised again and a number of organisations agreed to be invoiced for the samples which they will receive. Finally, Dr. Moore reviewed the procedure for peel testing. Professor Williams agreed to provide software to the participants for the analysis of the test data. Dr. Rime (Tetra Pak) very kindly distributed samples of the packaging laminate for the forthcoming round robin. This will be co-ordinated by Dr. Moore (ICI), to whom all enquires should be addressed.

And here ended a very busy, but enjoyable three days. Those people not having to rush off enjoyed a memorable lunch at Lac Retaud in brilliant sunshine. On Saturday, those remaining were treated to a spectacular ridge traverse along Les Velards (1978m), starting from the Col de la Croix. This was much enjoyed by all who came. The date of the next meeting will be 16-18th October 1996, again at Eurotel, Les Diablerets. We hope to see you all there again.

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Deadline

Copy for ESIS Newsletter 31
Winter 1996/1997

The next ESIS Newsletter, nr. 31 (Winter 1996/1997) is scheduled to be mailed during February 1997. Deadline for copy is:

January 15, 1997

Second Symposium on Advances in Fatigue Crack Closure Measurement and Analysis

November 12-13, 1997
San Diego, California, USA

Papers are invited for a Symposium on Advances in Fatigue Crack Closure Measurement and Analysis, sponsored by ASTM Committee E-8 on Fatigue and Fracture. The symposium will be held November 12-13, 1997 in San Diego, California, USA, in conjunction with the November 10-12, 1997 standards development meetings of Committee E-8.

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Topic

This symposium will highlight recent advances in both basic research and engineering applications of closure behavior. Plasticity, roughness, oxide, and other closure mechanisms will be considered. Major subject areas will include experimental measurement and data analysis techniques, analytical modeling, use of closure information to explain/correlate crack growth rates, and applications of closure concepts in engineering design and analysis.

Call for Papers

Copies of the official Call for Papers and the ASTM Paper Submittal Form are available from the symposium co-chairmen:

R. Craig McClung
Southwest Research Institute
P. O. Drawer 28510
6220 Culebra Road
San Antonio, TX 78228-0510, USA,
Tel: 210/522-2422
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James C. Newman, Jr.
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MS 188E
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Tel: 757/864-3487
Fax: 757/864-8911

and from ASTM:

Dorothy F. Savini, Symposia Operations
ASTM
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959, USA
Tel: 610/832-9677

Abstracts

Prospective authors must submit a title, a 250-300 word abstract, and the ASTM Paper Submittal Form to Ms. Savini at ASTM by December 15, 1996. The symposium co-chairmen will notify authors by January 30, 1997 of their paper's acceptability for presentation at the symposium. All accepted manuscripts to be peer reviewed for the anticipated Special Technical Publication (STP) will be due at ASTM by September 12, 1997.

The abstract must include a clear definition of the objective and approach of the work discussed, pointing out material that is new, and present sufficient details regarding results. The presentation and manuscript must not be of a commercial nature nor can it have been previously published. Because a limited number of abstracts will be accepted, be sure that the abstract is complete to allow for careful assessment of the paper's suitability for this symposium. ASTM may print and distribute the abstracts at the symposium with the approval of the symposium co-chairmen. Please do not send abstracts by fax because they do not reproduce clearly.