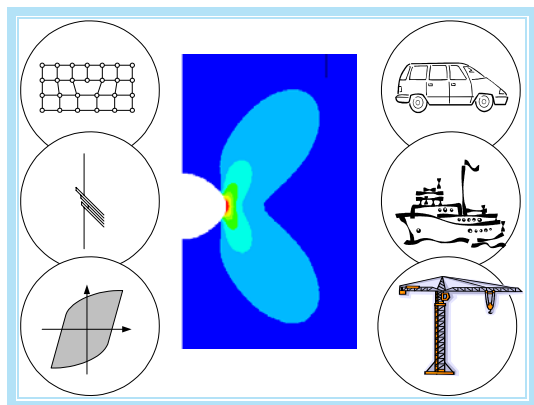




**Société Française de Métallurgie  
et de Matériaux**

**INTERNATIONAL CONFERENCE  
FATIGUE AND PLASTICITY  
FROM MECHANISMS TO DESIGN  
JIP 2008**

**12th International Spring Meeting  
Douzièmes Journées Internationales de Printemps**



**PARIS - May 20-22, 2008**

## PROGRAMME AND REGISTRATION

[www.JIP2008.eu](http://www.JIP2008.eu)



[www.e-i-s.org.uk](http://www.e-i-s.org.uk)

### ORGANIZING COMMITTEE

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and the members of the Bureau of the SF2M Fatigue Commission

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## COOPERATING ORGANIZATIONS

<b>ASTM International, Standards Worldwide</b> <a href="http://www.astm.org/">http://www.astm.org/</a>	
<b>AFM, Association Française de Mécanique</b> <a href="http://www.afm.asso.fr/">http://www.afm.asso.fr/</a>	
<b>DVM, Deutsche Verband für Materialforschung und -prüfung</b> <a href="http://www.dvm-berlin.de/">http://www.dvm-berlin.de/</a>	
<b>EIS, The Engineering Integrity Society</b> <a href="http://www.e-i-s.org.uk/">http://www.e-i-s.org.uk/</a>	

## TARGET AND TOPICS

Design of mechanical components is mainly performed in the elastic domain. However, in order to initiate fatigue cracks, plasticity is needed on the either microscopic or macroscopic scale, depending on fatigue regime (high cycle versus low cycle).

From a macroscopic point of view, plasticity can be induced by the shape irregularity of components or by overload. Locally, plasticity is influenced by the microstructure of the material (porosities, inclusions, grain orientation,...). Moreover, components often receive treatments, such as deep rolling, shot peening, and prestressing, that generate local plasticity resulting in a residual stress field that influences the fatigue strength.

The understanding of local cyclic mechanisms is a key step for modelling of fatigue behaviour. This understanding along with improved physics-based prediction approaches is necessary for deriving more robust practical design rules.

The objectives of the 2008 spring meeting of the SF2M is to review the state of the art with regard to the relationship between microstructure of materials, cyclic behaviour and fatigue design of components.

This topic is important to nearly all industries: power generation, off-shore, railway, aeronautic, automotive, mechanical industries,... This subject concerns the overall industrial chain, from research centres and material suppliers, to mechanical component manufacturers and system designers.

Topics are:

1. **experimental methods and determination of plasticity,**
2. **fatigue cyclic behaviour and microstructure**
3. **modelling and plasticity criteria,**
4. **fatigue crack initiation and propagation behaviour**
5. **applications and examples.**

## ORGANISATION

### LANGUAGE

Language will be English.

### PROCEEDINGS

Manuscripts for the Conference proceedings (8 pages maximum, camera ready) are expected before **March 30<sup>th</sup> 2008**.

The book will be distributed upon arrival, at registration desk.  
A CD Rom will be provided.

### SUMMARY OF DEADLINES

Camera ready manuscripts: **March 30<sup>th</sup>, 2008**  
Registration for authors before: **March 30<sup>th</sup>, 2008**.

### CONFERENCE SECRETARIAT:

**SF2M, Société Française de Métallurgie et de Matériaux**  
250 rue Saint Jacques  
75005 Paris  
Tel.: 33 (0)1 46 33 08 00 ; Fax: 33 (0)1 46 33 08 80  
[sfmm@wanadoo.fr](mailto:sfmm@wanadoo.fr)

## VENUE

The conference will take place in the conference centre:

**"asiem"**

6, rue Albert de Lapparent  
75007 Paris

**Tel.: 33 (0)1.42.73.13.36**

Fax: 33 (0)1.45.67.56.98

Internet website: <http://www.asiem.fr>

It is located in Paris, the Left Bank, in the 7th "arrondissement", (see map, and comments on last page), near Unesco, Hôtel des Invalides, Ecole Militaire and Eiffel tower. It can be reached:

**from downtown Paris:**

- the closest subway (métro) station is "Segur"
- other possible station "Sèvres Lecourbe"

**from Roissy Charles-de-Gaulle airport:** take the RER B, to "Pont Saint Michel" then the subway (métro) line N°10 direction "Pont de St Cloud" down to "Segur".

**from Orly airport:** take the Orly Bus, until "Denfert Rochereau" terminus. Then subway line N°6 direction "Etoile" down to "Sèvres Lecourbe".

## HOTEL ACCOMMODATION

Participants are invited to reserve their rooms early: spring is a very busy tourist season in Paris.

- Requests for hotel accommodation can be addressed to: Chantal Iannarelli,

**Congrès Scientifiques - Services (C2S)**

2 Rue des Villarmains - 92210 Saint-Cloud

Fax: 33 (0)1 47 71 90 05 – E.mail : [c2s@club-internet.fr](mailto:c2s@club-internet.fr)

## REGISTRATION DESK

Welcome and registration desk will be open:

- on Tuesday May 20<sup>th</sup> from 8:00 to 12:40 and from 13:30 to 18:00,
- on Wednesday May 21<sup>st</sup> from 9:00 to 12:10 and from 13:30 to 18:00,
- on Thursday May 22<sup>nd</sup> from 9:00 to 12:20.

## CONFERENCE FEES:

Participants	Before	After
	April 30 <sup>th</sup> , 2008	April 30 <sup>th</sup> , 2008
Students	250 €	300 €
Speakers and SF2M members	500 €	530 €
Other participants	550 €	580 €
<b>Accompanying person</b>	<b>120 €</b>	<b>120 €</b>

The fees of participants include:

- Attendance to the conference sessions,
- Proceedings (book and CDRom),
- Lunches and coffee breaks during the 3 days,
- Visit of the Tour Eiffel machinery and conference dinner on May 21<sup>st</sup>.

The fees of accompanying persons include only

- Visit of the Tour Eiffel machinery and conference dinner on May 21<sup>st</sup>.

### CANCELLATION:

Participants cancelling their registration by e-mail, fax, or letter before May 12 will be refunded 50 % of their registration fees. No refund will be possible for cancellations made after May 12.

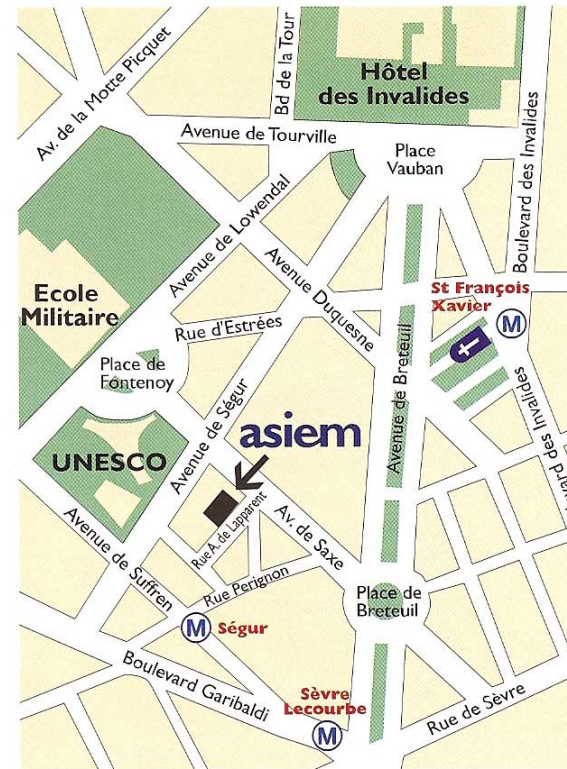
### JACQUES POMEY AWARD:

This award will be attributed at the end of the conference to the best young author (less than 32 years old)  
M. Fabien SZMYTKA, winner 2007 will be awarded on May 21<sup>st</sup> during a brief ceremony at the beginning of the conference dinner.

### LUNCHES AND CONFERENCE DINNER:

Lunches will be served as upstanding buffet in the area of the poster and the exhibition.

A visit of the Eiffel Tower machinery is scheduled on Wednesday 21<sup>st</sup> at 19:00.  
The conference dinner will take place in a restaurant on the Seine River Bank near the Eiffel Tower.



Autobus : n° 28 - 39 - 49 -70 -92

  
Location de salles  
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Site internet : [www.asiem.fr](http://www.asiem.fr)

Tuesday May 20, morning		
09:00		<i>Registration - Welcome breakfast</i>
09:30		Opening by <u>Henri-Paul LIEURADE</u>
TOPIC 1 -Experimental methods		
09:50	1	<b>Experimental determination of fully-coupled kinematical and thermal fields at the scale of metals grains under cyclic loading.</b> <u>L. BODELOT</u> , <u>L. SABATIER</u> , <u>E. CHARKALUK</u> , <u>P. DUFRENOY</u> (Laboratoire de Mécanique de Lille – UMR CNRS 8107, Villeneuve d'Ascq, France)
10:10	2	<b>Study of crack propagation by pyrometry in gigacycle regime.</b> <u>N. RANC*</u> , <u>L. ILLOUL*</u> , <u>D. WAGNER**</u> , <u>P. C. PARIS***</u> , <u>C. BATHIAS**</u> (*LMSP, UMR CNRS 8106, ENSAM-ParisTech, Paris, France, **LEEE, EA 387, Université Paris X - Nanterre, Ville d'Avray, France, **LAMEFIP, EA 2727, Talence, France)
10:30		<i>Coffee break - Exhibition visit</i>
11:00	3	<b>Cumulation of damage in low cycle fatigue and gigacycle fatigue.</b> <u>H. ZHIYONG</u> , <u>D. WAGNER</u> , <u>C. BATHIAS</u> (University Paris X, LEEE, Ville d'Avray, France)
11:20	4	<b>Complementarity of various experimental techniques for studying low-cycle fatigue damage mechanisms in a duplex stainless steel.</b> <u>A. EL BARTALI</u> , <u>V. AUBIN</u> , <u>S. DEGALLAIX</u> (Laboratoire de Mécanique de Lille - UMR CNRS 8107 -, Villeneuve d'Ascq, France)
11:40	5	<b>A study of Marker-bands in Fatigue.</b> <u>H. ALDROE</u> , <u>A. TOUGUI</u> , <u>F. LACROIX</u> , <u>N. RANGANATHAN</u> (LMR, Polytech Tours-DP, Tours, France)
12:00	6	<b>Relationship between fatigue limit and measured temperature by thermography in welded part.</b> <u>A. SETO *</u> , <u>B. WEBER **</u> (*Steel Research Laboratories, Nippon Steel Corporation, Chiba, JAPAN, **Arcelor Research SA, Arcelor-Mittal, Maizieres-les-Metz, France)
12:20		<i>Lunch</i>

Tuesday May 20, afternoon		
TOPIC 2 -Fatigue cyclic behaviour and microstructure		
13:30	7	<b>Keynote presentation: Polycrystalline approach of cyclic behaviour of f.c.c. alloys:intra-granular heterogeneity.</b> <u>X. FEAUGAS</u> (Laboratoire d'Etude des Matériaux en Milieux Agressifs - EA316, La Rochelle, France)
14:00	8	<b>Cyclic plasticity mechanisms of the 25cr-7ni-0.25N duplex stainless steel investigated by atomic force microscopy.</b> <u>D. SALAZAR</u> , <u>I. SERRE</u> , <u>J-B. VOGT</u> (Laboratoire de Métallurgie Physique et Génie des Matériaux ENSCL/USTL CNRS, Université des Sciences et Technologies de Lille, France)
14:20		<b>Posters presentation</b>
14:50		<b>Posters session</b>
15:50		<i>Coffee break - exhibition visit</i>
16:20	9	<b>Internal crack initiation by coalescence of cavities nucleated at a/b interfaces along localized slip bands in a Ti alloy during room temperature fatigue, dwell-fatigue and creep.</b> <u>P. LEFRANC*</u> , <u>V. DOQUET**</u> , <u>C. SARRAZIN-BAUDOUX*</u> , <u>M. GERLAND*</u> (*LMPM, ENSMA, Poitiers, UMR CNRS 6617 - **LMS, Ecole Polytechnique, Palaiseau, UMR CNRS 7649, France)
16:40	10	<b>Identification of HCF Properties of a Cast Copper-aluminium Alloy by Self-Heating Measurements under Cyclic Loadings.</b> <u>A. EZANNO*</u> , <u>C. DOUDARD*</u> , <u>S. CALLOCH*</u> , <u>T. MILLOT**</u> , <u>J-L. HEUZÉ***</u> (*LBMS, ENSIETA/UBO, BREST, ** DCNS-Propulsion, Indret, La Montagne, ***DGA, Paris, France)
17:00	11	<b>Anisotropic fatigue behaviour in forged Steel.</b> <u>E. PESSARD</u> , <u>F. MOREL</u> , <u>A. MOREL</u> (Laboratoire Procédé Matériaux Instrumentation de l'ENSAM d'Angers, France)
17:20	12	<b>Low cycle fatigue behaviour of fine grained austenitic stainless steels.</b> <u>J-B. VOGT</u> , <u>S. BROCHET</u> , <u>A. POULON</u> (Laboratoire de Métallurgie Physique et Génie des Matériaux ENSCL/USTL CNRS, Université des Sciences et Technologies de Lille, France)
17:40		<i>End of session</i>

Wednesday May 21, morning		
TOPIC 3 Plasticity criteria		
09:00	13	<b>Keynote presentation : A quick overview of the anatomy of cyclic plasticity models.</b> G. CAILLETAUD(ENSMP Centre des Matériaux, Evry, France)
09:30	14	<b>Validation and comparison of lifetime calculation methods of low-cycle-fatigue loaded components.</b> W. EICHLSEDER* **, H. KÖBERL*, G. WINTER*, (*Christian Doppler Laboratory for Fatigue Analysis, University of Leoben, Austria, **Chair Mechanical Engineering, University of Leoben, Austria)
09:50	15	<b>A Multiplicative AF Kinematic Hardening Model.</b> K. I. KOUROUSIS*, G.J. SARIDIS*, Y.F. DAFALIAS*** (*Department of Mechanics, School of Applied Mathematical and Physical Sciences, National, Technical University of Athens, Hellas, Greece, **Department of Civil and Environmental Engineering, University of California, Davis,USA)
10:10	16	<b>Coupling of forming process and fatigue design computations: a local approach.</b> M.L. FACCHINETTI*, Bastien WEBER**, Cédric DOUDARD***, Sylvain CALLOCH*** (*PSA Peugeot Citroën, Vélizy-Villacoublay, France, **ARCELOR MITTAL, Maizières-les-Metz, France, ***Laboratoire de Mécanique des Structures Navales, Brest, France)
10:30		<b>Coffee break - exhibition visit</b>
11:00	17	<b>New Enhanced Description of the Cyclic Behavior of Materials</b> J.M. SPRAUEL*, A. LAHLAL*, H. MICHAUD** (*EA(MS) <sup>2</sup> , - IUT, Aix en Provence, **ASCOMETAL C.R.E.A.S., Hagondange, France)
11:20	18	<b>Cyclic plasticity for different structural steels under biaxial low-cycle fatigue.</b> L. REIS, B. LI, M. de FREITAS (Departamento de Engenharia Mecânica, Instituto Superior Técnico, Lisboa, Portugal)

Wednesday May 21, morning		
TOPIC 3 Plasticity criteria		
11:40	19	<b>High cycle fatigue in C36 steel under out-of-phase tension/torsion cycling: experiment and interpretation employing a mesoplasticity/damage model.</b> Q. Hu. VU*, L. FLACELIERE**, Y. NADOT*, A. DRAGON* (*ENSMA, LMPM, UMR CNRS 6617, Futuroscope, **CREAS-ASCOMETAL, Hagondange)
12:00		<b>End of session 3 - Lunch - exhibition visit</b>
Wednesday May 21, afternoon		
13:30		<b>Posters session</b>
TOPIC 4 - Crack initiation and growth		
14:00	20	<b>Keynote presentation: Fatigue crack propagation and history effects induced by plasticity.</b> S. POMMIER (ENS LMT Cachan, France)
14:30	22	<b>A critical comparison of the conventional localized approach and the short crack approach to fatigue crack initiation at a notch.</b> N. RANGANATHAN, (Laboratoire de Mécanique et Rhéologie, Polytech Tours, DP, Université François Rabelais de Tours, France)
14:50	23	<b>The effect of prestrain on the fatigue crack propagation in a 304L stainless steel.</b> K. VOR, C. SARRAZIN-BAUDOUX, C. GARDIN, D. BERTHEAU, C. AMZALLAG, J. PETIT (LMPM, UMR CNRS 6617, ENSMA,Chasseneuil du Poitou, France)
15:10	24	<b>Validity of 2D numerical energetic fatigue criterion.</b> F. CHALON, S. MEO, N. RANGANATHAN (Laboratoire de Mécanique et Rhéologie, Productique Department, Polytech'Tours, University François Rabelais de Tours, France)
15:30	25	<b>Influence of cyclic indentation in progressive and constant mode on the glasses fatigue.</b> A. CHORFA*, M. HAMIDOUCHE**, M. A. MADJOUBI**, F. PETIT*** (* Department of mechanics, Skikda university, Algeria, **non-metallic material laboratory, department of mechanics, Sétif university, Algeria, *** Belgian ceramic research centre (BCRC), Mons, Belgium)
15:50		<b>Coffee break and exhibition visit</b>

<b>Wednesday May 21, afternoon</b>		
<b>TOPIC 4 - Crack initiation and growth</b>		
16:20	26	<b>Screening effect of forging defect by residual stresses induced by shot peening Influence on fatigue limit.</b> L. FLACELIERE, P. DAGUIER (Ascométal – CREAS, Hagondange)
16:40	27	<b>Identification data for multiaxial fatigue criterion: initiation or failure S-N curve ?.</b> Y. NADOT*, A. NASR*** C. BOURAOU***, R. FATHALLAH*** (*Laboratoire de Mécanique et de Physique des Matériaux, UMR CNRS no. 6617, ENSMA, Futuroscope, France, **Laboratoire de Génie Mécanique, Ecole Nationale d'Ingénieurs de Monastir, Monastir, Tunisie, ***Laboratoire de Génie Mécanique, Institut supérieur de transport et de la logistique, Sousse, Tunisie)
17:00	28	<b>Progressive loading in numerical modelling of plasticity induced crack closure.</b> F.V. ANTUNES, D. RODRIGUES (CEMUC, Department of Mechanical Engineering, University of Coimbra, Portugal)
17:20	29	<b>An investigation of the crack propagation tool steel X38CrMoV5 (AISI H11) in SE(T) specimens.</b> M. SHAH*, C.MABRU**, C. BOHER*, S. LE ROUX*, F. REZAÏ-ARIA* (*Laboratoire Centre de Recherche, Outillages, Matériaux et Procédés (CROMeP) – Université Toulouse Ecole Mines Albi (EMAC), **Département Mécanique des Structures et Matériaux (DMSM), d'Institut Supérieur de l'Aéronautique et de l'Espace (ISAE), France)
18:00 à 22:00		<b>Visit of the Eiffel Tower Machinery Jacques Pomey 2007 prize : Fabien SZMYTKA Conference dinner on the Seine River (fixed boat)</b>

<b>Thursday May 22, morning</b>		
<b>TOPIC 5: Applications</b>		
09:00	30	<b>Keynote presentation: A Critical Review of the Bäumer-Seeger method for estimating the strain-life fatigue properties of metallic materials.</b> P.A. BLACKMORE (Jaguar-Land Rover, Warks, England)
09:30	31	<b>Analytical and Experimental Approach of Residual Stress induced by the manufacturing of mechanical parts, and their stability in fatigue.</b> A. LAHLAL**, J.M. SPRAUEL*, H. MICHAUD** (*EA(MS) <sup>2</sup> , IUT, Aix en Provence, **ASCOMETAL C.R.E.A.S, Hagondange, France)
09:50	32	<b>Amorçage et propagation d'une fissure dans des joints soudés sollicités en compression.</b> M. BOUSSEAU, T. MILLOT (CESMAN DCNS,France)
10:10	33	<b>Numerical simulation of pressurized water reactor environment low cycle fatigue tests.</b> S. COURTIN, C. DE SANSAL, P. GILLES, J.A. LE DUFF (AREVA NP SAS, Paris La Défense, France)
10:30	34	<b>Low cycle fatigue strength of cold forging die steels.</b> R. EBARA*, J. KATAYAMA**, S. YAMAMOTO*, R. UEJI**, M. KAWAMURA**, A. OGURA***, Y. KONDO***, S.HAMAYA*** (*Department of Mechanical System Engineering, Hiroshima Institute of Technology, Hiroshima, Japan, **Department of Advanced Materials Science, Kagawa University, Takamatsu, Japan, ***Nichidai Corporation ,Kyoto, Japan)
10:50		<b>Coffee break - exhibition visit</b>

Thursday May 22, morning		
TOPIC 5: Applications		
11:20	35	<b>Study of a naval welded structure regarding fatigue damage: modelling and experiments.</b> C. ERNY, N. LAUTROU, D. THÉVENET, M. KORNER, J.Y. COGNARD (Laboratoire de Mécanique des Structures Navales, ENSIETA, Brest, France)
11:40	36	<b>Fatigue design of notched components with stress gradient and cyclic plasticity.</b> H. MAITOURNAM, K. DANG VAN, J-F. FLAVENOT* (*anciennement CETIM), (LMS, Ecole Polytechnique, Palaiseau, France)
12:00	37	<b>A study on the Fatigue Life and Mechanical Properties of the Braking Disk due to the Temperature Change.</b> J. KIM, B. C. GOO, H. Y. JEONG, Y. H. YOU (Korea Railroad Research Institute, Woram-Dong, Uiwang-City, Gyeonggi-Do, Korea)
12:20		<b>End of session 5 - end of conference.</b> <b>Lunch</b>

POSTERS	
P50	<b>Experimental and numerical study of a crack in aluminium shell with inner reinforcing foam layer.</b> A. FAYZA *, T. LAZGHAB**, Lotfi CHELBI** Brahim REZGUI** (*Laboratory of Mechanics, Structures and Technological Development , High Institute of Sciences and Techniques, Montfleury, Tunis, Tunisia, **Unité de Recherche Génie Matériau, Ecole Nationale des Ingénieurs de Tunis, Tunisia)
P51	<b>Microstructure and Fatigue Behavior of Nitrogen Ion Beam Implanted Chromium Steels</b> V.A BYELI *, V.A. KUKAREKO**, E.G. BILENKO*, A.A. KOLESNIKOVA* (*Physical-Technical Institute of the National Academy of Sciences of Belarus, **Joint Institute of Mechanical Engineering of the National Academy of Sciences of Belarus)
P52	<b>The influence of a liquid metal on fatigue crack behaviour in a 9Cr1MoNb-V martensitic steel for next nuclear systems.</b> J-B. VOGT*, I. SERRE**, J-C. GLEZ**, J-D. MITHIEUX** (*Laboratoire de Métallurgie Physique et Génie des Matériaux ENSCL/USTL CNRS, Université des Sciences et Technologies de Lille, France, **UGINE & ALZ Research Center, Isbergues, France)
P53	<b>Advantages and Limitations of Resonant Fatigue Testing Machines.</b> I. KLOPFER (RUMUL Russenberger AG, Neuhausen am Rheinfall, Switzerland)
P54	<b>Mechanical testing procedures and fatigue associated mechanisms of silica optical fibres.</b> I. SEVERIN***, M. POULAIN***, R. EL ABDI**, Gheorghe AMZA* (*Politehnica University of Bucharest, Fac. IMST, Bucharest, Romania, **LARMAUR, FRE CNRS 2717, Université de Rennes 1, France, ***Lab. Mat. Photoniques, UMR 6226, Université de Rennes 1, France)
P55	<b>EBSA analysis of dwell-fatigue fracture surface in Titanium alloy IMI834.</b> E. UTA*, N. GEY*, P. BOCHER**, M. HUMBERT*, J. GILBERT*** (*Laboratoire d'Etude des Textures et Applications aux Matériaux, LETAM, CNRS UMR 7078, ISGMP, Université de Metz, France, **École de Technologie Supérieure, Montréal, PQ, Canada, ***Laboratoire de Fiabilité Mécanique, Ecole Nationale d'Ingénieurs de Metz, France)
P56	<b>Modelling residual stresses from Nd-YAG laser welded joints.</b> F. ANTUNES*, J.M. COSTA*, J.T.B. PIRES**, J.P. NOBRE*, L.P. BORREGO*** (*CEMUC, Department of Mechanical Engineering, University of Coimbra- Polo II, Portugal, **Department of Mechanical Engineering, Polytechnic Institute of Castelo Branco, Castelo Branco, ***Department of Mechanical Engineering, Polytechnic Institute of Coimbra, Portugal)



**POSTERS**

P57	<p><b><i>Influence of Frequency and Loading Waveform on the Corrosion Fatigue Crack Propagation Behaviour of the Aluminium Alloy 2024-T351.</i></b>  <u>F. MENAN</u>, G. HENAFF (LMPM-ENSMA, Futuroscope Chasseneuil, France)</p>
P58	<p><b><i>Weld S-N curve evaluation for automotive durability analysis using hot spot stress method.</i></b>  Hyuk-Sun KWON (POSCO, Korea)</p>
P59	<p><b><i>Etude de l'état de surface de Matériaux frittés par Microscope à force atomique.</i></b>  <u>Tahar SAYAH*</u>, Khaled HAMOUDA*, Soltane LEBAILI*, Abdelwaheb AMROUCHE** (* Laboratoire des Sciences et Génie des Matériaux, Faculté de Génie Mécanique et Génie des Procédés U.S.T.H.B, Alger, Algérie, **Laboratoire de Mécanique, Université des Sciences et Technologies de Lille (Lille 1), Villeneuve d'Ascq, France)</p>
P60	<p><b><i>Phase Transformations on the Strength and Fatigue Performance of CP-Titanium.</i></b>  <u>Ming-Jen TAN</u>, Huanzhou SOH, Yahya SHARABIANI (School of Mechanical &amp; Aerospace Engineering, Nanyang Technological University, Singapore)</p>
P61	<p><b><i>Morphology of the interface of a deposit alloy type satellite on steel and his evolution in thermal fatigue.</i></b>  A. SELLIDJ*; <u>S. LEBAILI*</u>, P.LOUURS** (*Laboratoire : Science et Génie des Matériaux, Faculté de Génie mécanique et Génie des procédés, Université des Sciences et de la Technologie Houari Boumediene, Alger, Algérie, (**Centre de Recherche Outillage Matériaux et Procédés, Ecole des Mines d'Albi Carmaux, ALBI, France)</p>
P62	<p><b><i>Fatigue strength of concrete and glass fiber reinforced cementitious matrix composites.</i></b>  <u>B. REDJEL</u>, N-E. ARABI (Civil engineering laboratory, Badji Mokhtar University, Annaba, Algeria)</p>
P63	<p><b><i>Étude de la fiabilité de composants actifs et passifs soumis à des sollicitations mécaniques.</i></b>  <u>C. LE COQ***</u>, A. TOUGUI*, M.-P.STEMPIN**, L. BARREAU**, N. RANGANATHAN* (*Laboratoire de Mécanique et Rhéologie, Polytech Tours, Département Productique, Université François Rabelais de Tours, **ST Microelectronics, Tours, France)</p>
P64	<p><b><i>Thermal fatigue and wear behaviour of 304l stainless steel coating.</i></b>  A. BOUDEBANE, <u>M. LABAÏZ</u>, S. BOUDEBANE (Laboratory of Metallurgy and Materials Engineering, BADJI-Mokhtar University, Annaba, Algeria)</p>
P65	<p><b><i>Comparison of Elastic and Inelastic Finite Element Modeling of Cyclic Thermo-Mechanical Shock.</i></b>  K. G. F. JANSSENS (Paul Scherrer Institute, Switzerland.)</p>