

**INTERNATIONAL SYMPOSIUM ON  
LIQUID METAL PROCESSING AND CASTING**

***LMPC 2011***



**PRES de l'Université de Lorraine  
Nancy, France**

**September 25 - 28, 2011**

**[www.lmpc2011.org](http://www.lmpc2011.org)**

**Conference Co-Chairs**

**Alain Jardy**

**Jean-Pierre Bellot**

**Programme Co-Chairs**

**Matthew J.M. Krane**

**Rodney L. Williamson**

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# International Symposium on Liquid Metal Processing and Casting

## ORGANIZATION

The Conference is organized by **Institut Jean Lamour -Ecole des Mines de Nancy** on behalf of **SF2M** (Société Française de Métallurgie et de Matériaux).

## SCOPE

This Conference is the 9<sup>th</sup> in a series of International Symposia previously held at Santa Fe, NM and Nancy, France.

## SESSIONS

- **Vacuum Arc Remelting,**
- **Electroslag Remelting,**
- **Steel Processing,**
- **Structure, Properties and Inclusions,**
- **Titanium Casting and Processing,**
- **Aluminum/Silicon Casting and Processing.**

## WELCOME

The registration desk will be open:

- at the Grand Hôtel de la Reine, Place Stanislas, on Sunday 25 September from 06:00 pm to 07:30 p.m.
- on the three Conference days, the welcome desk will then be open from 8:30 a.m. at the entrance of "PRES", 34 cours Léopold, Nancy

## SCIENTIFIC COMMITTEE

Matthew J. M. Krane	Purdue University	(US)
Rodney L. Williamson	Remelting Technologies	(US)
A. Stewart Ballantyne	MeltMet Technologies LLC	(US)
Joseph J. Beaman	University of Texas at Austin	(US)
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Larry Jackman	ATI Allvac	(US)
Alain Jardy	Institut Jean Lamour Nancy	(F)
Koji Kajikawa	Japan Steel Works	(J)
Alec Mitchell	University of British Columbia	(Ca)
Ashish Patel	Carpenter Technology Corp.	(US)
Mark Suer	Special Metals Corporation	(US)
R. Mark Ward	University of Birmingham	(UK)
<b>Awards Chairman:</b>		
Koulis Pericleous	University of Greenwich	(UK)

## LOCAL ORGANIZATION COMMITTEE

Jean-Pierre Bellot	<a href="mailto:jean-pierre.bellot@mines.inpl-nancy.fr">jean-pierre.bellot@mines.inpl-nancy.fr</a>
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# GENERAL INFORMATION

## VENUE

Nancy is located 300 km east of Paris, 150 km west of Strasbourg, in the centre of the region of Lorraine. Travel from Paris takes 1.5 hours by train (TGV). The conference will take place at the **"PRES" (Pôle de Recherche et d'Enseignement Supérieur de l'Université de Lorraine)**, 34, cours Léopold, Nancy

Nancy, historical capital of Lorraine, is world-famous for its superb Place Stanislas and for the work of the artists of the "Ecole de Nancy".

## LANGUAGE

The language of the symposium is English. No translation will be provided.

## PROCEEDINGS

The proceedings will be distributed to the participants at the registration desk upon their arrival.

## REGISTRATION

Participants are asked to register **before August 31, 2011**.  
(registration form is available at [www.lmpc2011.org](http://www.lmpc2011.org)).

## REDUCED RATES FOR TRANSPORT WITHIN FRANCE

On the registration form, participants can request information on how to obtain reduced rates for travel within France, on French railways, SNCF.

## CONFERENCE FEES

- **550 Euros: non-members of SF2M or of TMS**
- **500 Euros: SF2M members and TMS members**
- **150 Euros: special student fee.**
- **+50 Euros increase for late registration (after August 31, 2011)**

The fee includes:

- **attendance to the Symposium sessions,**
- **two cocktails buffets (Sunday 25th and Monday 26th)**
- **banquet dinner (Tuesday 27th)**
- **volume of Proceedings + USB Flash drive**
- **a one year free subscription to the SF2M, if you are non-member.**

## ACCOMPANYING PERSONS

Conference dinner	75 Euros
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Accompanying persons are invited (free of charge) to the coffee breaks and the two cocktail buffets.

## CANCELLATION

Participants cancelling their registration by e-mail, fax or letter before Sept. 9<sup>th</sup>, 2011 will be refunded 50 % of their registration fee. No refund will be possible for cancellations made after September 9<sup>th</sup>, 2011.

# International Symposium on Liquid Metal Processing and Casting






## List of sponsors: private sponsorship

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# International Symposium on Liquid Metal Processing and Casting

## List of sponsors: institutions

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Financial support from our institutional partners is very gratefully acknowledged.

# International Symposium on Liquid Metal Processing and Casting

25 - 28 September 2011, Nancy  
PRES de l'Université de Lorraine – 34 Cours Léopold

## LMPC 2011

### Programme

Time		Sunday, Sept. 25, 2011
18:00		Registration at Grand Hôtel de la Reine
19:30		Cocktail buffet, Grand Hôtel de la Reine, Place Stanislas
Time	n°	Monday, Sept. 26, 2011
08:30		Registration at PRES de l'Université de Lorraine
08:50		Opening Remarks
09:00		<b>KEYNOTE</b>
		<b>SESSION 1 : VACUUM ARC REMELTING</b>
09:40	1	Experimental Study of the Current Distribution during Vacuum Remelting of Steel <i>A. Risacher<sup>1</sup>, P. Chapelle<sup>1</sup>, A. Jardy<sup>1</sup>, J. Escaffre<sup>2</sup> (<sup>1</sup>Institut Jean Lamour, Nancy, France, <sup>2</sup>Aubert&amp;Duval, Les Ancizes, France)</i>
10:05	2	Numerical Simulation of the Melting of the Consumable VAR Electrode – 2D and 3D Effects <i>A. Malik, B. Dussoubs, P. Chapelle, J.P. Bellot, H. Combeau, A. Jardy (Institut Jean Lamour, Nancy, France)</i>
10:30		<b>Coffee break &amp; Posters</b>
11:00	3	Detailed Modeling of the Solidification of Vacuum Arc Remelted Zirconium Ingots <i>M. Revil-Baudard<sup>1,2</sup>, A. Jardy<sup>1</sup>, M. Založnik<sup>1</sup>, H. Combeau<sup>1</sup>, F. Leclerc<sup>2</sup>, V. Rebeyrolle<sup>2</sup> (<sup>1</sup>Institut Jean Lamour, Nancy, France, <sup>2</sup>AREVA NP CEZUS, UGINE, France)</i>
11:25	4	A Reduced-Order Thermal Model for Dynamic VAR Pool Depth Control <i>J.J. Beaman, R.L. Williamson, L.F. Lopez (University of Texas, Austin, TX, USA)</i>
11:50	5	VAR Control Using a Reduced-Order Ingot Pool Depth Model <i>R.L. Williamson<sup>1</sup>, J.J. Beaman<sup>1</sup>, R.M. Aikin<sup>2</sup> (<sup>1</sup>University of Texas, Austin, TX, USA, <sup>2</sup>Los Alamos National Laboratory, Los Alamos, NM, USA)</i>
12:15		<b>Lunch time</b>

Time	n°	<b>Monday, Sept. 26, 2011 (continued)</b>
		<b>SESSION 2 : ELECTRO SLAG REMELTING</b>
14:00	6	3D Simulation of the Melting during an Industrial Scale Electro-Slag Remelting Process <i>A. Kharicha, A. Ludwig, M.Wu (University of Leoben, Leoben, Austria)</i>
14:25	7	Electrode Immersion Depth Effects in the ESR Process <i>A.D. Patel (Carpenter Technology Corp., Reading, PA, USA)</i>
14:50	8	Investigation of the Implications of the Current Conductive Mold Technology with Respect to the Internal and Surface Quality of ESR Ingots <i>H. Holzgruber<sup>1</sup>, W. Holzgruber<sup>1</sup>, A. Scheriau<sup>1</sup>, M. Knabl<sup>1</sup>, M. Kubin<sup>1</sup>, J. Korp<sup>2</sup>, R. Pierer<sup>3</sup> (<sup>1</sup>INTECO GmbH, Bruck-Mur, Austria, <sup>2</sup>Breitenfeld Edelstahl AG, Mitterdorf im Mürztal, Austria, <sup>3</sup>University of Leoben, Leoben, Austria)</i>
15:15	9	A Comparison of Predictions of Transport Phenomena in Electroslag Remelting to Industrial Data <i>M.J.M. Krane<sup>1</sup>, M. Fahrman<sup>2</sup>, J. Yanke<sup>1</sup>, E.E. de Obaldia<sup>1</sup>, K. Fezi<sup>1</sup>, J. Busch<sup>1</sup> (<sup>1</sup>Purdue University, West Lafayette, IN, USA, <sup>2</sup>Haynes International Inc., Kokomo, IN, USA)</i>
15:40		<b>Coffee &amp; Posters</b>
16:10	10	Thermal State of the Electrode during the Electroslag Remelting Process <i>A. Kharicha, A. Ludwig, M.Wu (University of Leoben, Leoben, Austria)</i>
16:35	11	Modification of Non-Metallic Inclusions in the ESR Process by Steel-Slag Interaction: Thermodynamic and Experimental Considerations <i>S. K. Michelic<sup>1</sup>, R. Tanzer<sup>2</sup>, W. Schützenhöfer<sup>2</sup>, C. Bernhard<sup>1</sup> (<sup>1</sup>University of Leoben, Leoben, Austria, <sup>2</sup>Böhler Edelstahl GmbH &amp; Co KG, Kapfenberg, Austria)</i>
17:00	12	The Influence of the Slag Composition on the Desulphurization of Ni-based Superalloys <i>J. Morscheiser<sup>1</sup>, L. Thönnessen<sup>2</sup>, B. Gehrman<sup>2</sup>, B. Friedrich<sup>1</sup> (<sup>1</sup>RWTH Aachen University, Aachen, Germany, <sup>2</sup>ThyssenKrupp VDM GmbH, Altena, Germany)</i>
17:25	13	ESR of Hollow Ingots: New Approaches to a Traditional Problem <i>B. Fedorovskii<sup>1</sup>, L. Medovar<sup>2</sup>, G. Stovpchenko<sup>2</sup>, V. Petrenko<sup>2</sup>, D. Bogachov<sup>2</sup>, V. Zhuravel<sup>2</sup> (<sup>1</sup>Elmet-Roll, Kyiv, Ukraine, <sup>2</sup>E.O. Paton Electric Welding Institute, Kyiv, Ukraine)</i>
17:50	14	Mathematical Modeling of Electroslag Casting with Liquid Metal <i>Y. Dong, X. Zhang, Z. Jiang, X. Zang, X. Deng (Northeastern University, Shenyang, P.R. China)</i>
18:15		<b>Finish</b>
		<b>Monday, Sept. 26, 2011 evening</b>
19:30		<b>Cocktail buffet : Salle d'honneur des Universités, 11, Place Carnot</b>

Time	n°	<b>Tuesday, Sept. 27 2011</b>
		<b>SESSION 3 : STEEL PROCESSING</b>
08:45		<b>Registration at PRES de l'Université de Lorraine</b>
09:00	15	Slag-Steel Equilibrium Calculations by Computational Thermodynamics: Comparison with the Plant Data <i>K. Riyahi<sup>1</sup>, P. Ölund<sup>1</sup>, M. Selleby<sup>2</sup> (1Ovako Hofors AB, Hofors, Sweden, 2KTH, Stockholm, Sweden)</i>
09:25	16	Optimisation of Turbulence Inhibitors in a Two Strand Continuous Casting Tundish: Numerical Modelling <i>T. Merder, A. Fornalczyk (Silesian University of Technology, Katowice, Poland)</i>
09:50	17	Non-Contact Local Flow Measurement Using Lorentz Force Velocimetry in Tandem Arrangement <i>D. Jian, Ch. Karcher (Ilmenau University of Technology, Ilmenau, Germany)</i>
10:15		<b>Coffee break &amp; Posters</b>
10:45	18	Numerical Modelling of Grain Structure in Continuous Casting of Steel: A Meshless Macro - Micro Concept <i>B. Šarler<sup>1</sup>, A.Z. Lorbiecka<sup>1</sup>, R. Vertnik<sup>2</sup> (1University of Nova Gorica, Nova Gorica, Slovenia, 2Štore Steel, Štore, Slovenia)</i>
11:10	19	Investigation of a Possible Route for Oxygen Transport via the Metal Droplets in Top-Blown Steel Converters <i>G. Djambazov<sup>1</sup>, K. Pericleous<sup>1</sup>, B. Lebon<sup>1</sup>, Y. Doh<sup>1,2</sup>, A. Jardy<sup>2</sup>, P. Chapelle<sup>2</sup>, G. Ghazal<sup>3</sup>, P. Gardin<sup>3</sup> (1University of Greenwich, London, UK, 2Institut Jean Lamour, Nancy, France, 3ArcelorMittal R&amp;D, Maizières-les-Metz, France)</i>
11:35	20	Influence of Subflux Turbulence Controller on Hydrodynamic Conditions in the Continuous Casting Slab Tundish <i>A. Cwudziński (Czestochowa University of Technology, Czestochowa, Poland)</i>
		<b>SESSION 4 : STRUCTURE, PROPERTIES, INCLUSIONS</b>
11:50	21	Structure and Property Control in Thin-Wall Ductile Iron Castings by Optimizing the Molten Metal Processing <i>A. Javid<sup>1</sup>, C. Labrecque<sup>2</sup>, M. Gagné<sup>2</sup> (1CANMET, Hamilton, ON, Canada, 2 Rio Tinto Iron &amp; Titanium, Sorel-Tracy, QC, Canada)</i>
12:15		<b>Lunch time</b>
14:00	22	A Simple Slice Model for Prediction of Macrosegregation in Continuously Cast Billets: Influence of Different Solid Diffusion Models <i>I. Vušanović<sup>1</sup>, R. Vertnik<sup>2,3</sup>, B. Šarler<sup>3</sup> (1University of Montenegro, Podgorica, Montenegro, 2Štore Steel, Štore, Slovenia, 3 University of Nova Gorica, Nova Gorica, Slovenia)</i>
14:25	23	As-Cast Microstructure of Re-Containing Ni-Based Single Crystal Superalloys under Directional Solidification with Liquid Metal Cooling <i>L. Liu, G. Liu, T. Huang, J. Zhang, H. Fu (Northwestern Polytechnical University, Xi'an, P.R. China)</i>
14:50	24	Three-Dimensional Macrosegregation Simulation of a Ni-based Superalloy during Lateral Directional Solidification <i>T. Sawada, K. Kajikawa, F. Takahashi, H. Yamada (Japan Steel Works, Muroran, Hokkaido, Japan)</i>
15:15	25	Study of Columnar-Equiaxed Transition and Twinned Dendrites Growth of Hypoeutectic Alloy with Synchrotron Radiation <i>J. Zhang<sup>1</sup>, Q. Dong<sup>1</sup>, Y. Dai<sup>1</sup>, F. Li<sup>1</sup>, B. Sun<sup>1</sup>, H. Xie<sup>2</sup> (1JiaoTong University, Shanghai, P.R. China, 2Institute of Applied Physics, Shanghai, P.R. China)</i>
15:40		<b>Coffee break &amp; Posters</b>



Time	n°	<b>Tuesday, Sept. 27, 2011 (continued)</b>
		<b>SESSION 4 : STRUCTURE, PROPERTIES, INCLUSIONS (continued)</b>
16:10	26	Densities of Solid and Liquid Phases of Co-Cr and Co-Cr-W Alloys <i>K. Oikawa, Y. Oba, K. Anzai, K. Shinagawa, T. Omori (Tohoku University, Sendai, Miyagi, Japan)</i>
16:35	27	Freckle Formation Experiment with Ni-Based Ternary Alloys using Sand Mold <i>K. Kajikawa, F. Takahashi, T. Sawada, H. Yamada (Japan Steel Works, Muroran, Hokkaido, Japan)</i>
17:00	28	Analytical Modeling of Solute Redistribution, Solid/Liquid Interface Stability and Initial Transient Region Size during the Unidirectional Solidification of Alloy 718 <i>L. Nastac (University of Alabama, Tuscaloosa, AL, USA)</i>
17:25	29	Recent Developments with Cold Wall Induction Melting Using a Plasma Arc Torch Assist <i>R.E. Haun<sup>1</sup>, R.A. Lampson<sup>1</sup>, M. Charles<sup>1</sup>, W.R. Imler<sup>2</sup>, R.W. Balliett<sup>3</sup> (<sup>1</sup>Retech Systems LLC, Ukiah, CA, USA, <sup>2</sup>Squirrel Hill Associates, Oakland, CA, USA, <sup>3</sup>Metallurgical Consultants and Analysts LLC, Westborough, MA, USA)</i>
17:50		<b>Finish</b>
		<b>Tuesday, Sept. 27, 2011 evening</b>
18:00		<b>Bus Departure from PRES to Pont-à-Mousson</b>
19:00		<b>Conference dinner : Abbaye des Prémontrés, Pont-à-Mousson</b>

Time	n°	<b>Wednesday, Sept. 28, 2011</b>
		<b>SESSION 5 : TITANIUM CASTING AND PROCESSING</b>
09:00	30	Modelling Centrifugal Casting: The Challenges and Validation <i>N. J. Humphreys<sup>1</sup>, D. McBride<sup>2</sup>, D. M. Shevchenko<sup>1</sup>, T.N. Croft<sup>2</sup>, P. Withey<sup>3</sup>, N. R. Green<sup>1</sup>, M. Cross<sup>2</sup> (<sup>1</sup>University of Birmingham, Birmingham, UK, <sup>2</sup>Swansea University, Swansea, UK, <sup>3</sup>Rolls-Royce plc, Derby, UK)</i>
09:25	31	The Alloying of Titanium by Oxygen in the Process of Chamber Electro-Slag Remelting <i>A.D.Ryabtsev, O.A. Troyanskyy, S.M. Ratiev, V.V. Pashynskyy, O. A. Snizhko (Donetsk National Technical University, Donetsk, Ukraine)</i>
09:50	32	Continuous Casting of Titanium in the Cold Crucible <i>V. Bojarevics, A. Roy, K. Pericleous (University of Greenwich, London, UK)</i>
10:15		<b>Coffee break &amp; Posters</b>
		<b>SESSION 6: ALUMINIUM/SILICON CASTING AND PROCESSING</b>
10:45	33	Validation of Foundry Process for Aluminum Parts with Flow3D Software <i>N.T. Niane<sup>1</sup>, J.P. Michalet<sup>2</sup> (<sup>1</sup>PSA Peugeot Citroën, La Garenne Colombes, France, <sup>2</sup>PSA Belchamp, Voujeaucourt, France)</i>
11:10	34	Numerical Modelling of the Hydrogen Removal Process from Liquid Aluminium <i>M. Saternus<sup>1</sup>, T. Merder<sup>1</sup>, P. Warzecha<sup>2</sup> (<sup>1</sup>Silesian University of Technology, Katowice, Poland, <sup>2</sup>Czestochowa University of Technology, Czestochowa, Poland)</i>
11:35	35	Refining of Silicon by Electron Beam Melting <i>C. Lehnert<sup>1</sup>, J. Flinspach<sup>1</sup>, H. Franz<sup>1</sup>, U. Biebricher<sup>1</sup>, B. Scheffel<sup>2</sup>, R. Labitzke<sup>2</sup>, P. Feinäugle<sup>2</sup>, G. Mattausch<sup>2</sup> (<sup>1</sup>ALD Vacuum Technologies GmbH, Hanau, Germany, <sup>2</sup>Fraunhofer Institute, Dresden, Germany)</i>
12:10		<b>Finish</b>

## POSTERS

<b>P1</b>	Droplet Formation in Small Electroslag Remelting Processes <i>A. Kharicha, A. Ludwig, M. Wu (University of Leoben, Leoben, Austria)</i>
<b>P2</b>	Design of ESR Slags According to Requested Physical Properties. Part 1: Electrical Conductivity <i>K. Wroblewski, J. Fraley, J. Fields, R. Werner, S. Rudoler (American Flux and Metal, Winslow, NJ, USA)</i>
<b>P3</b>	Work Optimization of the Three-Strand Tundish – Physical Modeling <i>J. Pieprzyca (Silesian University of Technology, Katowice, Poland)</i>
<b>P4</b>	ULCOLYSIS: Liquid Steel from Iron Ore Electrolysis in Molten Slag <i>H. Lavelaine de Maubeuge, F. Stoessel, J.-P. Birat (ArcelorMittal R&amp;D, Maizières-les-Metz, France)</i>
<b>P5</b>	Production of High Quality Bearing Steels by Electroslag Continuous Casting Process <i>X. Zang, Z. Jiang, H. Li (Northeastern University, Shenyang, P.R. China)</i>
<b>P6</b>	Modeling of Behavior of Injected Nonmetallic Particles in Liquid Metal Bath and Analysis of Their Influence on the Metal Purification Processes <i>Y. Kostetsky, A. Mach (Donetsk National Technical University, Donetsk, Ukraine)</i>
<b>P7</b>	Performance Evaluation of a Nickel Base Cast Superalloy Processed in Equiaxed and Directionally Solidified Modes for Gas Turbine Applications <i>M. Chatterjee<sup>1</sup>, A. Pani Kishore<sup>1</sup>, B. Gopala Krishna<sup>2</sup>, M. Narayana Rao<sup>1</sup> (<sup>1</sup>Mishra Dhatu Nigam Limited, Hyderabad, India, <sup>2</sup>Defence Metallurgical Research Laboratory, Hyderabad, India)</i>
<b>P8</b>	Numerical Description of Electromagnetic Force Pattern in Liquid Metal <i>Y. Bai (Baoshan Iron &amp; Steel Co., Shanghai, P.R. China)</i>
<b>P9</b>	Inclusion Behaviour during the Electron Beam Button Melting Test <i>B. Defay<sup>1,2</sup>, J. Jourdan<sup>1</sup>, P. Chapelle<sup>1</sup>, J.P. Bellot<sup>1</sup> (<sup>1</sup>Institut Jean Lamour, Nancy, France, <sup>2</sup>SNECMA Gennevilliers, Colombes, France)</i>