



# ***Solidification Course 2017***

## **Announcement**

26<sup>th</sup> Edition

868 participants from 319 companies from 38 countries until today!

**Les Diablerets (Switzerland)**

April 30 – May 5, 2017

# THE LECTURERS

Courses, discussions and exercises will be presented by the following lecturers:

<i>Prof. Christoph Beckermann</i>	Professor, University of Iowa, Iowa City, USA
<i>Prof. Hervé Combeau</i>	Professor, Lorraine University, Institut Jean Lamour, Nancy, France
<i>Prof. Jon Dantzig</i>	Professor Emeritus, University of Illinois, Urbana, USA
<i>Dr Marco Gremaud</i>	EMEA Executive Managing Director, ESI Group, Lausanne, Switzerland
<i>Prof. Matthew John M. Krane</i>	Professor, Purdue University, USA
<i>Prof. Andreas Ludwig</i>	Professor, Montanuniversitaet Leoben, Austria
<i>Assoc. Prof. André Phillion</i>	Associate Professor, McMaster University, Hamilton, Ontario, Canada
<i>Prof. Michel Rappaz</i>	Professor Emeritus, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland

# SCOPE OF THE COURSE

For the twenty-sixth consecutive year, Calcom ESI, in collaboration with the Swiss Federal Institute of Technology of Lausanne (EPFL), is organizing a solidification course with the participation of renowned lecturers from Swiss, French, Austrian and US universities.

This one-week course held in English is designed for engineers and scientists from industry and research centers who wish to improve their knowledge in the field of solidification. Participants should have a degree in materials science, metallurgy, mechanical engineering, physics or chemistry.

Although the theoretical background of solidification is reviewed, the course is oriented towards the application of solidification theories to industrial processes. The macroscopic aspects of the processes (transfer phenomena) are addressed together with the formation of microstructures and defects (microscopic phenomena). Connection between macroscopic and microscopic aspects, such as the prediction of microstructures and defects as a function of process parameters, is also emphasized. Examples of the application of these concepts to industrial processes, such as shape casting, continuous casting and directional solidification, are given.

Exercises, discussions, films and computer demonstrations are organized in order to apply, practice and visualize the content of the lectures. Due to the limited number of participants (maximum 35-40), interactions between the participants and the eight lecturers will allow an optimum transfer of knowledge, during the whole week, as was demonstrated during the previous editions.

Finally, private or group discussions can take place during social hours, evenings and Wednesday afternoon in order to treat more specific problems which the participants may encounter.

The Course is following very closely the content of the Book "Solidification" from J.A. Dantzig and M. Rappaz.

# PROGRAMME

## Sunday April 30, 2017

From 18:30 Welcome of the participants, registration  
19.15 Dinner

## Monday May 01, 2017

08.30 - 09.45 Introduction / Overview of solidification phenomena M. Gremaud  
09.45 - 10.15 Break  
10.15 - 11.15 Phase diagrams J. Dantzig  
11.15 - 12.15 Discussion/Exercises (Phase diagrams) C. Beckermann / J. Dantzig  
12.30 Lunch  
13.45 - 14.45 Heat and Mass transfer M. Krane  
14.45 - 15.45 Discussion/Exercises (Heat & Mass transfer) H. Combeau / M. Krane  
15.45 - 16.15 Break  
16.15 - 17.15 Nucleation and grain refinement in alloys A. Ludwig  
17.15 - 18.00 In-situ visualization of solidification (films) M. Rappaz  
18.30 Social Hour  
19.30 Dinner

## Tuesday May 02, 2017

08.30 - 09.30 Microsegregation C. Beckermann  
09.30 - 10.30 Discussion/Exercises (Microsegregation) A. Ludwig / C. Beckermann  
10.30 - 11.00 Break  
11.00 - 12.00 Dendritic structures J. Dantzig  
12:15 Lunch  
14.00 - 15.00 Eutectic solidification A. Ludwig  
15.00 - 16.15 Discussion/Exercises (Dendrites-Eutectic) M. Krane / A. Ludwig  
16.15 - 16.45 Break  
16.45 - 17.45 Mushy zone modeling H. Combeau  
18.30 "Swiss Evening" dinner

### **Wednesday May 03, 2017**

08.30 - 09.30	Porosity	C. Beckermann
09.30 - 10.30	Discussion/Exercises (Microporosity)	H. Combeau / C. Beckermann
10.30 - 11.00	Break	
11.00 - 12.00	Hot tearing	M. Rappaz
12.15	Lunch	
	Free time (free discussions with the professors)	
18.00	Social hour	
19.00	Dinner	

### **Thursday May 04, 2017**

08.30 - 09.30	Thermomechanics	A. Phillion
09.30 - 10.45	Discussion/Exercises (Thermomech. - Hot tearing)	M. Krane / A. Phillion
10.45 - 11.15	Break	
11.15 - 12.15	Modeling of columnar and equiaxed solidification	H. Combeau
12.30	Lunch	
14.15 - 15.15	Solidification path in multi-component systems	M. Rappaz
15.15 - 16.30	Discussion/Exercises (Multi-comp)	C. Beckermann / M. Rappaz
16.30 - 17.00	Break	
17.00 - 18.00	Answer to questions – Pannel session	All
18.15	Social hour	
19.15	Dinner	

### **Friday May 05, 2017**

08.30 - 09.30	Macrosegregation	M. Krane
09.30 - 10.30	Discussion/Exercises (Macrosegregation)	A. Ludwig / M. Krane
10.30 - 11.00	Break	
11.00 - 11.45	Synthesis – Linking solidification phenomena	M. Rappaz
11.45	Concluding remarks	M. Gremaud
12.00	End	
12.15	Lunch	

# PRACTICAL INFORMATION

- Dates:** from Sunday April 30, 2017 evening  
to Friday May 5, 2017, mid-day (lunch included).
- Location:** Hotel "Eurotel Victoria", Les Diablerets, Switzerland  
(Mountain resort in the Swiss Alps, 100 km from Geneva)  
[www.eurotel-victoria.ch/diablerets/](http://www.eurotel-victoria.ch/diablerets/)
- Access:** Train or car (2.5 hours by train from Geneva Airport and  
4.5 hours by train from Zurich Airport).
- Registration:** As soon as possible with the enclosed registration form  
(to be sent by post or scanned by email to Calcom ESI).  
*Thanks to send also an email to [solidification.course@esi-group.com](mailto:solidification.course@esi-group.com) in  
order to make sure that we have well received your registration.*

Only the first 40 persons will be taken into consideration.  
All registrations will be confirmed in writing within 2-3 weeks.

- Price:** EUR 4'290.- (EUR = Euro currency )  
This price includes the registration fee, the booklet of the course  
with the lecture notes, the book "Solidification", the hotel (full  
board), drinks during the meals, social hours and coffee breaks.

The course fee should be paid before April 15, 2017.

*A confirmed registration corresponds to a firm commitment. This means that  
the course fee should be paid in any case, unless the registration is cancelled  
in writing at least 45 days prior to the start of the course.*

- Address for  
payment:** Banque Cantonale Vaudoise (BCV)  
Case postale 300  
CH-1001 Lausanne, Switzerland  
SWIFT code: BCVLCH2L  
Clearing number: 767  
Calcom ESI account: CO E 5001.77.74  
IBAN: CH12 0076 7000 E500 1777 4  
To the order of CALCOM ESI

An information package with the practical details will be sent in advance (around  
middle of April 2017) to each registered participant.

# REGISTRATION

## Solidification Course 2017

Les Diablerets (Switzerland) April 30 – May 5, 2017

Mr  Mrs  Ms  First name: \_\_\_\_\_

Last name: \_\_\_\_\_

Company: \_\_\_\_\_

Position in the company: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ Country: \_\_\_\_\_

Phone: \_\_\_\_\_ Fax: \_\_\_\_\_

E-mail: \_\_\_\_\_

(As the email address is quite often difficult to read on faxed registration forms, thanks to send us an email in parallel to your registration. This will allow to double check it. Send your email to [solidification.course@esi-group.com](mailto:solidification.course@esi-group.com))

Indicate below the requested information:

- Material(s) of primary interest: \_\_\_\_\_

- Process(es) of primary interest: \_\_\_\_\_

- Working in industry  Working in National Institute  Working in University

- If working in industry specify: R&D  Production  Quality control

Describe with 3 keywords your main interests/expectations/topics to be addressed in the course:

\_\_\_\_\_

**Limited to the first 40 registrations. All registrations will be confirmed.**

Payment Information (no credit card):

- Payment by bank transfer  
 Payment by check (drawn on a Swiss Bank)

Signature of the participant: \_\_\_\_\_

Authorized <sup>\*\*/</sup> signature(s) of the company: \_\_\_\_\_

<sup>\*\*/</sup> I have noticed that this registration is a firm commitment and that the course fee will be paid in any case, unless this registration is cancelled in writing at least 45 days prior to the start of the course.

**Return as soon as possible by post to:**

*CALCOM ESI, Route Cantonale 105, CH-1025 St-Sulpice, Switzerland  
(Please send also an email to: [solidification.course@esi-group.com](mailto:solidification.course@esi-group.com) to check that we have well received your registration. All registrations will be confirmed.)*

*Previous courses were attended by participants from the following companies or institutions:*

**Argentina** INTI **Australia** BHP, Comalco, Uni Wollongong **Austria** AMAG, ARC, Böhler, Eisenwerk Sulzau Werfen, Giesserei Institut, Hertwich Eng., Leoben University, LKR, Siemens, Voest-Alpine, TU Graz **Belgium** Allard Europe, Bekaert, Consolidated Precision Products, CRIF, Heraeus Electro-Nite Intl., KU Leuven, Magotteaux, Union Minière **Brazil** Electro Aço Altona, Gerdau, ITP, Villares Metals **Canada** Alcan, Aluminium Tech. Carlton Univ., Magotteaux, University of Windsor, University of Western Ontario **Czech Rep.** Mecas, Vitkovice Heavy Machinery, Technical Univ. Ostrava **Denmark** Jydsk, Univ. of Denmark **Finland** Outokumpu, VTT **France** ABS Centre Métallurgique, Airbus Helicopters, Alcoa Howmet, Aperam Isbergues, Asco Metal Creas, Aubert&Duval, Cabinet Braun, CEA, Cemef, Cezus, Cirimat, CLAL, Clecim, Constellium, Creusot-Loire Industrie, CTIF, Ecole des Mines Albi, Electricité de France, ENSAM, ESI Group, Fives Cryo, Fonderie Nouvelle Jouve, Forcast, Griset, Howmet, Imphy, Industeel, INPG, INPT, Institut Jean Lamour, IRSN, Le Bélier, Manoir Industries, Manoir St Briec, Metafensch, Montupet, Péchiney, Pont-à-Mousson, Renault, Rio Tinto Alcan, Safran, Saint-Gobain Cree, Sambre et Meuse, SCC, Sepr, SNECMA, Techpy, Trefimetaux, Turbine Casting, Ugine, Ugitech, Umicore, Unimetal, Univ. de Lorraine, Vallourec, Waeles, Wamar **Germany** Access, Airbus, Aleris, Aluminiumfeinguss Soest, Aurubis, Buderus Edelstahl, Daimler Chrysler, DLR, Fraunhofer, GKSS, Helmholtz Zentrum, Hydro, MAN, MKM, MTU, Otto Fuchs, Ritter AI, Salzgitter Mannesmann, Reiner Brach, Siempelkamp, Schmidt & Clemens, SMS Diemag, Thyssen, Tital, TU Dresden, TU Freiberg, VAW, Zollern **Greece** Alcor, Egnatia foundry, Elval **India** Anant, Concast, ESI India, GM, HAL, Jadavpur University, Kalyani Carpenter, Peekay Steel, Simplex Castings **Ireland** DePuy, Dublin Inst. Of Tech., Materials Ireland, Montupet **Israel** NRCN, Urdan **Italy** Area3, Brembo, Centro Ricerche FAR, Fiat, Centro Sviluppo Materiali, Danieli, ECOTRE, EMA, Europa Microfusioni Aerospaziali, Fonderia Atti, Metra, Microfusione Stellite, Politecnico di Torino, Teksid, Univ. of Bologna, Univ. of Brescia, Zanardi Fonderie **Japan** JIPS, Kyushu University, Mitsubishi Heavy Industries, Nippon Steel, Tokyo University **Korea** Hyundai Heavy Ind., Inst. Ind. Tech. **Mexico** Castech, Cinfusa, Ciateq **Netherlands** Bosch, Corus, ESA, Honeywell, Hoogovens, MI2, NIMR, Outokumpu, Shell, Tata Steel, TU Delft, Univ. of Groningen **New Zealand** Supreme Steel Precision **Norway** Elkem, Elkem Solar, Elkem Silicon Materials, Hycast, Hydro, IFE, NTNU, K.A. Rasmussen, Sintef **Poland** AGH, GE Polska, Rzeszow Univ. of Tech., Warsaw University, WSK **Portugal** Funfrap, Instituto Superior Tecnico, Zollern **Russia** Aviadvigatel OJSC, FSUE MMPP SALUT, KUMW, Perm National Research **Saudi Arabia** King Saud University, Sabic **Slovak Rep.** US Steel **Slovenia** Impol D.D., TGC Unitech, Univ. of Nova Gorica **South Africa** Mattek-CSIR, Scaw Metals **Spain** Analisis y Simulación, C4, Centro Metalurgico Azterlan, Cidaut, CTM, Edertek, Fagor Ederlan, Fuchosa, Inasmet, Labein, Mondragon Univ., Precicast, Sidenor, Univ. Vigo **Sweden** ABB, Erasteel Kloster, Gränges Technology, Lulea University, MEFOS, Ovako Steel, Sandvik Rock, SAPA, Swedish Foundry Ass., Swerea Swecast, Volvo Truck, Volvo Powertrain, TPC **Switzerland** Advanced Aerofoil Technologies, Alcan, Algroup, Asulab, Bühler, Cendres et Métaux, Concast, HES SO, Kugler Bimetal, Metalor, Novelis, Nussbaum, Precicast, PSI, PX Holding, Rolex, SMS Concast, Steel Consult, Sulzer, Swatch Group, Swissmetal, Swiss Steel, UMS, Unitechnologies, Varinor, Wolfensberger **Taiwan** Nat. Taiwan Uni. **Thailand** INN, Somboon **Turkey** Assan Kibar Group, CMS, Ereğli, Eyap Artema, FNSS Defense Systems, Gedik Döküm **United Arab Emirates** Dubai Aluminium, Gulf Extrusions, Masdar Institute **United Kingdom** AETC, Aeromet International, Alloy Wheels, Ashland, AWE, British Aerospace, Doncasters, GKN, Namtec, Rolls Royce, Sheffield Forgemasters, Sim-Cast, T&N Technology, Trittech Group, Univ. of Birmingham, Univ. of Cambridge, Univ. of Sheffield, Vulcan, Wall Colmonoy **USA** Alumax, Carnegie Mellon, Carpenter Technology, Caterpillar, Dura-Bar, Consolidated Metco, Ellwood Quality Steels, ESI R&D, Ford Motor Company, General Electric, GM, Hoeganaes, Honeywell Aerospace, Howmet, Los Alamos Natl. Lab., Naval Surface Center, NIST, Novelis, PCC Structural, Signicast Investment, Stuller, United Technologies, Virginia Tech, Wagstaff, West Coast Foundry, Wright Patterson AFB, Wyman Gordan