



Institute for Materials Science and Welding Univ.-Prof. Dipl.-Ing. Dr.techn. Christof Sommitsch



# FINAL PROGRAMME

10<sup>th</sup> International Seminar Numerical Analysis of Weldability 24 - 26 September 2012

Graz - Seggau - Austria

IIW Commission IX WG Mathematical Modelling of Weld Phenomena



## Welcome note

## 10<sup>th</sup> International Seminar Numerical Analysis of Weldability Chairman: C. Sommitsch Co-Chairman: N. Enzinger Honorary Chairman: H. Cerjak

With the 10<sup>th</sup> International Seminar "Numerical Analysis of Weldability", a tradition of successful meetings will be continued. Since the first of these events in 1991, this seminar series has developed to be a world leading conference in the growing field of the development of methods for predicting the microstructure and properties of welds. It is both, of practical importance and academic interest and it supports the philosophy of computer modelling, which helps to optimise welding processes and consumables as well as the service behaviour of welded components. Leading experts in this field attend the seminar and present their latest results in the calm atmosphere of an ancient castle.

The seminar is organized by the Institute for Materials Science and Welding of Graz University of Technology under the patronage of IIW Commission IX, Working Group "Mathematical Modelling of Weld Phenomena".

The peer-reviewed papers will be published in the form of a book containing in-depth articles. Previous books are available from:

#### Mathematical Modelling of Weld Phenomena 1 - 6

Institute for Materials 1993, 1995, 1997, 1998, 2001, 2002 Book 533, 594, 650, 695, 738, 784

#### Mathematical Modelling of Weld Phenomena 7, 8 & 9

Verlag der Technischen Universität Graz, 2005, 2007, 2010

For the fifth time at this seminar, the **IIW Kenneth Easterling Best Paper Award** will be awarded to the paper which represents *"the best contribution made over the three years preceeding the award to the advancement of knowledge or practice in respect of the mathematical modelling of a welding phenomenon"*. The prize is sponsored by **Fronius International GmbH** and it is dedicated to the commemoration of Prof. Kenneth Easterling, the first co-chairman of this seminar series.

As in the previous seminars, the idea is to bring together the leading specialists in this research field and to exchange the state of the art of development and application of Numerical Analysis of Weldability. We try to do our best to assure a calm working atmosphere in a nice surrounding, accompanied by an attractive social programme.

All seminar attendees stay in *Schloss Seggau*, a nice remote castel in the wine area 40 km in the south direction of Graz. The discussion about the items presented in the seminar sessions can be continued during the common meals and the social events (reception, styrian evening, wine cellar visit etc.).

I wish you all a pleasant stay at Schloss Seggau and a successful and memorable seminar!



# The programme at a glance

unday, 23 <sup>rd</sup> September 2012 Arrival		Arrival day
	19:00	Welcome reception
		Special act: La Trombalia
		Dinner at Schloss Seggau
Monday, 24 <sup>th</sup> September 2012	08:30 - 16:45	Presentations
	16:45 - 17:30	Guided tour through Schloss Seggau
	18:00	Bus departure to dinner location
	19:00	Knight's banquet in the great hall of Schloss Kornberg
Tuesday, 25 <sup>th</sup> September 2012	08:30 - 17:40	Presentations
	18:30	Special act: Austrian miner sword dance
		Wine tasting and styrian evening
		Best paper award ceremony: Award
		sponsored by
Wednesday, 26 <sup>th</sup> September 2012	08:30 - 12:15	Presentations
	12:15 - 13:30	Lunch and end of the seminar

# Sponsors of the seminar



ARLSRUH



## Seminar programme

## Monday, 24<sup>™</sup> September 2012

08:30 - 09:05: Welcome address and introduction Rector TU Graz Harald Kainz, Chairman Christof Sommitsch

## I Melt pool & arc phenomena Chairmen: P. Mendez, J. Niu

#### 09:05 - 09:30 KEYNOTE

Multi-physical finite element simulation of an electromagnetic weld pool support in full-penetration high power laser beam welding of metal plates

M. BACHMANN, VJ. AVILOV, A. GUMENYUK, M. RETHMEIER: BAM Federal Institute for Materials Research and Testing, Berlin, Germany

J. M. CARPREAU: LaMSID UMR EDF-CNRS-CEA 2832, Clamart France

- 09:30 09:50 A numerical and experimental study of heat and mass transfer during GTA welding of different austenitic stainless steels K. KOUDADJE: EDF Research & Development, Chatou France, Aix-Marseille University IUSTI CNRS UMR 7343, France M. MEDALE: Aix-Marseille University IUSTI CNRS UMR 7343, France C. DELALONDRE: EDF Research & Development, Chatou France
- 09:50 10:10 **Different strategies to simulate a deep penetration welding process** *M. GATZEN, K. CHONGBUNWATANA: BIAS - Bremer Institut für angewandte Strahltechnik GmbH, Germany*
- 10:10 10:40 COFFEE BREAK sponsored by



ThyssenKrupp Tailored Blanks

10:40 - 11:00 Simulation of heat and fluid flow with the free surface in 3D gas tungsten arc welding X. KONG: CEA, DEN, DANS, DM2S, Gif-sur-Yvette, France; AREVA NP, Paris La Défense, France; LTDS, Ecole Nationale d'Ingénieurs de Saint-Etienne, Fr O. ASSERIN, S. GOUNAND: CEA, DEN, DANS, DM2S, Gif-sur-Yvette, France P. GILLES: AREVA NP, Paris La Défense, France J.-M. BERGHEAU: LTDS, Ecole Nationale d'Ingénieurs de Saint-Etienne, France M. MEDALE: Ecole Polytechnique Universitaire de Marseille, France 11.00 - 11.20 Numerical simulation of arc and metal transfer in gas metal arc welding M. HERTEL, U. FÜSSEL, M. SCHNICK: Technische Universität Dresden, Germanv U. REISGEN, O. MOKROV, A. ZABIROV: RWTH Aachen University, Germany A. SPILLE-KOHOFF: CFX Berlin Software GmbH, Germany

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11.20 - 11.40 Multiphysics modeling of GTAW process and experimental validation for investigating the weld pool formation S. SREEDHAR, S. ROUQUETTE, F. SOULIÉ, G. FRAS: LMGC, University of Montpellier - 2 CNRS, France 11.40 - 12.00 Modelling of the droplet formation process in GMA welding O. SEMENOV, V. DEMCHENKO, I. KRIVTSUN: Paton Welding Institute, Kyiv, Ukraine U. REISGEN. O. MOKROV. A. ZABIROV: RWTH Aachen University. ISF-Welding and Joining Institute, Germany 12:00 - 12:20 Study of the explosion effect in electrode metal droplets of binary AIMg alloys in GMA welding U. REISGEN, O. MOKROV, A. ZABIROV: RWTH Aachen University, ISF -Welding and Joining Institute, Germany I. KRIVTSUN, V. DEMCHENKO, O. LISNYI, I. SEMENOV: Paton Welding Institute, Ukraine

12:20 - 13:50 LUNCH

## II Modelling tools & computer programs Chairmen: T. Koseki, E. Kozeschnik

#### 13:50 - 14:15 **KEYNOTE**

Numerical Simulations of micro-, macro-, and mega-scale structurization by welding processes

M. MOCHIZUKI: Department of Materials and Manufacturing Science, Graduate School of Engineering, Osaka University, Japan

 14:15 - 14:35
 Towards the industrial application of welding simulation via standardisation

C. SCHWENK: BMW Group Research and Innovation Centre, Munich, Germany

- D. TIKHOMIROV: INPRO GmbH, Berlin, Germany
- B. LENZ: BMW Group Research and Innovation Centre, Munich, Germany
- J. HILDEBRAND: Bauhaus-University Weimar, Germany
- 14:35 14:55 **Optimization of a heat source using ABC algorithm** L. WITTWER, N. ENZINGER: Institute for Materials Science and Welding, Graz University of Technolgoy, Austria
- 14:55 15:15 Simulation of multi-pass welding of high strength steel H. GAO, R. K. DUTTA: Materials innovation institute, Delft, The Netherlands M. J. M. HERMANS, I. M. RICHARDSON: Metals Processing, Microstructure and Properties, Dept. Materials Science and Engineering, Delft University of Technology, The Netherlands
- 15:15 15:45 COFFEE BREAK sponsored by



15:45 - 16:05	Hybrid intelligent technique based models for estimating weld bead width and depth of penetration from the infra-red thermal images of weld pool N. CHANDRASEKHAR, M. VASUDEVAN, A. K. BHADURI, T. JAYAKUMAR: Metallurgy and Materials Group, Indira Gandhi Centre for Atomic Research, Kalpakkam, India
16:05 - 16:25	Linear friction welding of high strength chains: modelling and validation K. MUCIC, J. LOPERA: Institute for Materials Science and Welding, Graz University of Technology, Graz, Austria F. FUCHS: pewag GmbH, Kapfenberg, Austria N. ENZINGER: Institute for Materials Science and Welding, Graz University of Technology, Austria
16:25 - 16:45	OMS: A computer algorithm to develop closed-form solutions to multicoupled, multiphysics problems P. F. MENDEZ: Department of Chemical and Materials Engineering, University of Alberta, Edmonton, AB, Canada N. STIER: Columbia Business School, New York, NY, USA
18:00	Bus departure to dinner

# TUESDAY, 25<sup>™</sup> SEPTEMBER 2012

## III Cracking phenomena Chairman: M. Rethmeier

08:30 - 08:55	KEYNOTE Modelling of hot cracking phenomenon in welding with a coupled cellular automaton- finite element model A. NIEL, C. BORDREUIL, F. DESCHAUX-BEAUME, G. FRAS: Laboratoire de Mécanique et Génie Civil, UMR5008, Université Montpellier 2, France
08:55 - 09:15	Finite element analysis of the cast pin tear test T. C. LUSKIN, B. T. ALEXANDROV, J. C. LIPPOLD: The Ohio State University, USA S. L. MCCRACKEN: Electric Power Research Institute
09:15 - 09:35	Numerical investigations of hydrogen assisted cracking in duplex stainless steel microstructures T. MENTE, T. BÖLLINGHAUS: BAM Federal Institute for Materials Research and Testing, Berlin, Germany
09:35 - 09:55	Experimental and numerical analysis of local thermomechanical behaviour for hot cracking assessment in welds C. GOLLNOW, T. KANNENGIESSER: BAM Federal Institute for Materials Research and Testing, Berlin, Germany R. LAUER, M. DONG, R. RIEKERS: Eberspaecher GmbH & Co. KG, Germany

09:55 - 10:15 Simulation of multipass welding of a steel pipe including modelling of hydrogen diffusion and fracture mechanics assessment

 H. G. FJÆR: Institute for Energy Technology, Kjeller, Norway
 S. K. AAS, V. OLDEN: SINTEF Materials and Chemistry, Trondheim, Norway
 D. LINDHOLM: Institute for Energy Technology, Kjeller, Norway
 O. M. AKSELSEN: SINTEF Materials and Chemistry, Trondheim, Norway

 10:15 - 10:35 Numerical analysis of liquation cracking in aluminium alloy welded joints

 J. MARTIKAINEN, E. HILTUNEN: Department of Mechanical Engineering, Lappeenranta University of Technology, Finland
 V. KARKHIN, S. IVANOV: Department of Welding and Laser Technologies, St. Petersburg State Polytechnic University, Russia

10:35 - 11:05 COFFEE BREAK

12:30 - 14:00

LUNCH

#### **IV FSW**

### Chairman: J. Hattel

11:05 - 11:30	<b>KEYNOTE</b> <b>Novel approaches to modelling metal flow in friction stir spot welding</b> <i>A. REILLY, H. R. SHERCLIFF, G. J. MCSHANE: Department of Engineering,</i> <i>University of Cambridge, UK</i> <i>Y. CHEN, P. PRANGNELL: Materials Science Centre, School of Materials,</i> <i>University of Manchester, UK</i>
11:30 - 11:50	Material flow study during friction stir welding process using computational fluid dynamics simulation <i>M. AWANG: Mechanical Engineering Department, Universiti Teknologi</i> <i>Petronas, Seri Iskandar, Malaysia</i>
11:50 - 12:10	An estimation of variable stresses on friction stir welding tool M. MEHTA: Mechanical Engineering Department, Indian Institute of Technology Bombay, Mumbai, India G. M. REDDY, A. V. RAO: Defense Metallurgical Research Laboratory, Hyderabad, India A. DE: Mechanical Engineering Department, Indian Institute of Technology Bombay, Mumbai, India
12:10 - 12:30	Physical and numerical simulation of microstructure evolution in friction stir spot welding of AA6082 Z. GAO: School of Materials Science and Engineering, Henan Polytechnic University, Jiaozuo, China; Institute for Materials Science and Welding, Graz University of Technology, Austria J. T. NIU: School of Materials Science and Engineering, Henan Polytechnic University, Jiaozuo, China F. KRUMPHALS, N. ENZINGER, C. SOMMITSCH: Institute for Materials Science and Welding, Graz University of Technology, Austria

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# V Residual stresses & distortion Chairmen: N. Enzinger, M. Mochizuki

14:00 - 14:25	KEYNOTE Finite element modelling of welding residual stress evaluation in a tubular K-joint geometry C. ACEVEDO: ICOM Steel Structures Laboratory, EPFL, Lausanne, Switzerland J. M. DREZET: LSMX Computational Materials Laboratory, EPFL, Lausanne, Switzerland A. NUSSBAUMER: ICOM Steel Structures Laboratory, EPFL, Lausanne, Switzerland
14:25 - 14:45	Equivalent inherent strain method for prediction of welding induced distortion A. MENDIZABAL, M. SAN SEBASTIAN, A. ECHEVERRIA: LORTEK, Technological Centre, Ordizia, Spain
14:45 - 15:05	Finite element analysis of weld residual stress in an UOE linepipe subjected to mechanical expansion S. W. WEN: Tata Steel, Research, Development & Technology, Swinden Technology Centre, Moorgate, UK M. CONNELLY: Tata Steel Tubes Europe, Energy Manufacturing, Hartlepool UK
15:05 - 15:25	Welding of thick steel plates under rough environmental conditions J. KLASSEN, T. NITSCHKE-PAGEL, K. DILGER: Institute of Joining and Welding, Technische Universität Braunschweig, Germany
15:25 - 15:45	Numerical analysis of welding distortion behavior of a car door R. THATER: Fraunhofer IPK, Berlin, Germany W. PERRET: AUDI AG, Ingolstadt, Germany M. RETHMEIER: Fraunhofer IPK, Berlin, Germany; BAM, Division 9.3 Welding Technology, Berlin, Germany
15:45 - 16:05	Development of phase transformation-induced compressive residual stresses around the weld joint: Numerical modeling T. ALGHAMDI: Consulting Services Department-Saudi Aramco, USA S. LIU: Center for Welding, joining, and Coatings Research, Department of Metallurgical & Materials Engineering, Colorado School of Mines, USA
16:05 - 16:35	COFFEE BREAK

## VI Microstructure modelling in WM & HAZ

### Chairman: P. Mayr

16:35 - 17:00	KEYNOTE
	Progress in modeling of multi-phase multi-component precipitation kinetics in AI and Fe-based alloys
	E. KOZESCHNIK: Vienna University of Technology, Austria
17:00 - 17:20	Fracture toughness evaluation of thin Fe-Al intermetallic compound layer formed at reactive interface of dissimilar metal joints N. KYOKUTA, M. KOBA, T. ARAKI, S. NAMBU, J. INOUE, T. KOSEKI: Department of Materials Engineering, The University of Tokyo, Japan
17:20 - 17:40	Calculation of three-dimensional grain shape statistics from two-dimensional EBSD orientation data J. ZACHRISSON, J. BÖRJESSON: ESAB AB, Metallography, Gothenburg, Sweden
18:30	Special act: Austrian miner sword dance (group from St. Martin/Sulmtal) Wine tasting and Styrian Evening at Schloss Seggau

## Wednesday, 26<sup>™</sup> September 2012

# VII Service behaviour of welded structures

### Chairman: C. Sommitsch

#### 08:30 - 08:55 KEYNOTE

# Prediction of bearing capacity and fracture mode of spot welds of high strength steels

D. FABRÈGUE, S. DANCETTE, V. MASSARDIER, J. MERLIN: Université de Lyon, INSA de Lyon, MATEIS-UMR 5510, Villeurbanne, France R. ESTEVEZ: SIMAP, INPG, Saint Martin d'Heres Cedex, France T. DUPUY, M. BOUZEKRI: ArcelorMittal R&D, Voie Romaine, Maizières les Metz, France

08:55 - 09:15 Fracture mechanical analysis of cross tension test for high-strength steel spot welded joints F. WATANABE, S. FURUSAKO, H. HAMATANI, Y. MIYAZAKI AND T. NOSE: Nippon Steel Corporation, Futtsu, Chiba, Japan

09:15 - 09:35	Simulation of the mechanical behavior of dissimilar welded joints between Ni-based alloy and steel T. KLEIN, C. FEUILLETTE, M. SPEICHER, A. KLENK, K. MAILE: Materials Testing Institute University of Stuttgart, Germany
09:35 - 09:55	Numerical simulation on the effect of HAZ softening on static tensile strength of HSLA steel welds W. MAURER, W. ERNST, R. RAUCH, S. KAPL: Voestalpine Stahl GmbH, Linz, Austria R. VALLANT, N. ENZINGER: Graz University of Technology, Institute for Materials Science and Welding, Austria
09:55 - 10:30	COFFEE BREAK

## VIII Processes / miscellaneous Chairman: U. Reisgen

10:30 - 10:55	<b>KEYNOTE</b> Simulation of micro-plasmapowder deposition for advanced welding torch design K. ALALUSS, G. BÜRKNER, P. MAYR: Institute of Manufacturing and Welding Engineering, Chemnitz University of Technology, Germany
10:55 - 11:15	A multi-physic level set approach for the simulation of the hybrid laser / GMAW process O. DESMAISON, G. GUILLEMOT, M. BELLET: Mines ParisTech - Centre de Mise en Forme des Matériaux (CEMEF), CNRS UMR 7635, Sophia-Antipolis, France
11:15 - 11:35	Mathematical model of plasma jet for plasma arc brazing B. E. CARLSON, HP. WANG: General Motors Holdings LLC, USA G. A. TURICHIN, Y. A. VALDAITSEVA, S. Y. IVANOV, V. A. KARKHIN: St. Petersburg State Polytechnic University, Russia
11:35 - 11:55	<b>Soldering of aluminum matrix composites SICp/A356 and kovar alloy</b> J. T. NIU: Henan Polytechnic University, Jiaozuo, China; Harbin Institute of Technology, Harbin, China X. T. WANG, Z. GAO, D. F. CHENG: Henan Polytechnic University, Jiaozuo, China
11:55 - 12:15:	Summary and conclusion C. SOMMITSCH

#### 12:15 LUNCH

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# **End of Seminar**

## POSTERS

The posters are accessible during the whole seminar. Coffee breaks are served in the poster session rooms. All authors are kindly asked and invited to stay with their posters during the breaks.

Please visit the following exhibitors during the breaks:





## I Melt pool & arc phenomena

Three dimensional modelling and measurement of a GTAW electric arc and heat exchanges with a metallic weld plate

D. BOREL: EDF R&D department MRI, Chatou, France; CORIA, UMR 6614, Site Universitaire du Madrillet, Saint Etienne du Rouvray, France

J. M. CARPREAU: LaMSID UMR EDF-CNRS-CEA 2832, France

B. G. CHÉRON: CORIA, UMR 6614, Site Universitaire du Madrillet, Saint Etienne du Rouvray, France

C. DELALONDRE: EDF R&D department MFEE, Chatou, France

J. ANGLÈS: LAMSID UMR EDF-CNRS-CEA 2832, France

# A time dependent model of GMAW using experimentally determined geometry of wire and droplet

M. SCHNICK, M. HAESSLER, S. ROSE, M. HERTEL, U. FÜSSEL: Institute of Surface and Manufacturing Technology, Dresden University of Technology, Germany A. SPILLE-KOHOFF: CFX Berlin Software GmbH, Germany

#### Keyhole modeling of Nd:YAG laser welding of stainless steel butt joint

K. R. BALASUBRAMANIAN: National Institute of Technology, Mechanical Enginering, Tiruchirappalli, India

# Analysis of heat and fluid flow phenomena of double-sided V groove welds of high-strength low alloy steel

J. CHEN: BAM Federal Institute for Materials Research and Testing, Devision "Welding Technology", Berlin, Germany; Institute of Materials Joining, Shandong University, Jinan, China A. PITTNER, C. HEINZE: BAM Federal Institute for Materials Research and Testing, Devision "Welding Technology", Berlin, Germany

C. S. WU: Institute of Materials Joining, Shandong University, Jinan, China M. RETHMEIER: BAM Federal Institute for Materials Research and Testing, Devision "Welding Technology", Berlin, Germany

# II Modelling tools & computer programs

Study of kinematic strain hardening law in transient welding simulation M. OTTERSBÖCK, M. STOSCHKA, M. THALER AND H. KRAMPL: Lehrstuhl für Allgemeinen Maschinenbau, Montanuniversität Leoben, Austria

# Analysis of laser welding process parameters using central composite design of design of experiments

K. R. BALASUBRAMANIAN: National Institute of Technology, Mechanical Enginering, Tiruchirappalli, India

# Numerical analysis for obtaining feasible solution on maintenance welding at blast furnace of visakhapatnam steel plant - visakhapatnam - india

A. PANDI: Rashtriya Ispat Nigam Limited, Visakhapatnam Steel Plant, Visakhapatnam, Andhra Pradesh, India

#### Mathematical model of filler metal heating and melting for plasma arc brazing B. E. CARLSON, H.-P. WANG: General Motors Research and Development, USA V. A. KARKHIN, S. Y. IVANOV, G. A. TURICHIN, Y. A. VALDAITSEVA: St. Petersburg State Polytechnic University, Russia

**Combination of geometrical simplification techniques for very large welded structures** *M. SÖDERBERG, A. LUNDBÄCK: Division of Mechanics of Solid Materials, Luleå University of Technology, Sweden* 

## **III Cracking phenomena**

#### Simulation-based hot cracking analysis in Al laser welding

F. LU: School of Materials Science and Engineering, Shanghai Jiao Tong Univeristy, China H.-P. WANG, B. CARLSON: General Motor Research & Development, Warren, USA X. WANG: School of Materials Science and Engineering, Shanghai Jiao Tong University, China

### IV FSW

#### Thermal and microstructural modelling of AI-AI and AI-Fe friction stir spot welding

P. JEDRASIAK, A. REILLY, H. R. SHERCLIFF, G. J. MCSHANE: Department of Engineering, University of Cambridge, UK

Y. CHEN, J. D. ROBSON AND P. PRANGNELL: Materials Science Centre, School of Materials, University of Manchester, UK

Modelling heat generation by frictional and plastic dissipation in friction stir welding using a CFD approach

H. B. SCHMIDT: HBS Engineering ApS, Denmark

## V Residual stresses & distortion

Effect of weld pass sequence on residual stresses of a welded mild steel plate *J. R. V N J DHANYAMRAJU: GVP College of Engineering, Mechanical Engineering, Visakhapatnam, India* 

Prediction of welding distortions in a complex structure using finite element modelling: experimental validation

A. MENDIZABAL, M. SAN SEBASTIAN, A. ECHEVERRIA: LORTEK, Technological Centre, Ordizia, Spain

## VI Microstructure modelling in WM & HAZ

# Simulation of phase transformations for the calculation of the welding stresses in steel structures

A. S. KURKIN, E. L. MAKAROV, A. B. KURKIN: BMSTU, Welding and Testing, Moscow, Russia

#### On the influence of time and temperature on material characteristics

N. DEN UIJL, P. VAN LIEMPT, S. VAN BOHEMEN, K. BOS: Tata Steel, IJmuiden, The Netherlands

#### On the modeling of austenite grain growth in micro-alloyed HS steel S700MC

*M.* Rahman: Institute for Materials Science and Welding, Graz University of Technology, Austria *M.* Albu: FELMI-ZFE, Graz University of Technology, Austria

N. Enzinger: Institute for Materials Science and Welding, Graz University of Technology, Austria

#### VII Service behaviour of welded structures

#### The welded structure lifetime evaluation with account of technological factors A. S. KURKIN, G. P. BATOV AND I. N. PONOMAREVA: BMSTU, Welding and Testing, Moscow, Russia

#### Application of high pressure rolling to a friction stir welded aerospace panel

P. COLEGROVE, J. DING, M. BENKE, H. COULES: Welding Engineering and Laser Processing Centre, Cranfield University, UK

# Notes

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Graz University of Technology

#### Venue

The 10<sup>th</sup> International Seminar "Numerical Analysis of Weldability" will take place at Schloss Seggau, the former bishop residence in the Styrian wine area 40 km south of Graz, Austria.



#### How to reach Graz

Graz has direct scheduled flight connections served by Austrian Airlines, Lufthansa, InterSky, Robin Hood Aviation, TUIfly.com, Welcome Air, Ryanair from Vienna, Innsbruck, Linz, Munich, Frankfurt, Berlin, Cologne, Düsseldorf, Friedrichshafen, Zürich and London/Stansted.

### **Seminar Organisation**

Graz University of Technology, Institute for Materials Science and Welding and IIW Commission IX, Working Group "Mathematical Modelling of Weld Phenomena"

Chairman: Christof Sommitsch Institute for Materials Science and Welding Graz University of Technology Kopernikusgasse 24 A-8010 Graz

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