10th International Seminar
Numerical Analysis for Weldability

September 24 – 26, 2012
Graz - Seggau

WELCOME NOTE

information to the seminar

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sorted according to final programme

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To the
Participants of the 10th International Seminar
'Numerical Analysis of Weldability'

Graz, September 2012

10th International Seminar 'Numerical Analysis of Weldability'

Welcome

We welcome you very cordially at *Schloss Seggau* at the 10th International Seminar 'Numerical Analysis of Weldability'.

Please enjoy the beauty of the castle and the wine area of Southern Styria. If you have any questions please do not hesitate to contact any member of our group (you can recognize us by our orange name badges).

SCIENTIFIC PROGRAMME

Please find the final programme in your folder.

Authors are kindly asked to provide necessary information and material to the session chairmen. Please also check functionality of your presentation devices, such as computer etc., ahead of time. Assistance from our team will be available.

The final manuscripts which have not yet been submitted must be uploaded during the time of the conference. Please ask for support at the registration desk.

POSTER SESSIONS

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. If you need assistance with your poster, please contact **Bernhard Sonderegger or Johannes Tändl**.

MANUSCRIPTS

After the conference the manuscripts will be sent out for the peer-review process. After possible revision you must submit the original files and artwork. Detailed instructions will be communicated at a later time.

MEALS

All meals during the seminar will be served in the *'Speisesaal'* in the new part of the castle.

Vegetarian meals are available.

TRANSPORTATION

All participants who want and/or need assistance in organizing transportation to the railway station or the airport after the seminar can put their desired time of departure and destination into a list which will be available at the registration desk. For any questions please contact the registration desk.

SOCIAL EVENTS

Welcome party (Sunday, September 23, 2012, 19:00 hrs)

The welcome party will take place at the *'Glockenwiese'* (bad weather: *'Fürstenzimmer'*) in the upper castle courtyard. After a cocktail with a musical performance of the band *'La Trombalia'* (trumpet music), we will have a joint dinner in the *'Speisesaal'*.

Knight's banquet in the great hall of Schloss Kornberg (Monday, September 24, 2012, 19:00 hrs)

Bus departure to *Schloss Kornberg for the knight's banquet at* ***18:00 hrs***! The busses will wait in front of the castle.

Styrian Evening (Tuesday, September 25, 2012, 18:30 hrs)

Austrian miner sword dance: performance of a group from St. Martin/Sulmtal. Afterwards visit of the historic wine cellar at *Schloss Seggau* with wine tasting. Please take a sweater with you. After this event we will have a Styrian Evening with Styrian buffet in the *'Speisesaal'*.

If you have any questions, need assistance or something else, please do not hesitate to contact any member of our team. We wish you a pleasant stay at Seggau castle and a most successful seminar.

Christof Sommitsch, Norbert Enzinger, Isabella Scheiber
and the many members of the organizing team.

CONTENT

Posters

MULTI-PHYSICAL FINITE ELEMENT SIMULATION OF AN ELECTROMAGNETIC WELD POOL SUPPORT IN FULL-PENETRATION HIGH POWER LASER BEAM WELDING OF METAL PLATES

M. BACHMANN*, V. AVILOV*, A. GUMENYUK* AND M. RETHMEIER*

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ABSTRACT

The influence of an alternating current (ac) magnetic field during full-penetration laser beam welding of thick metal plates was investigated numerically using a three-dimensional steady state model calculating for the fluid flow, temperature and electromagnetic field variables. The finite element software (FEM) COMSOL Multiphysics was used. Most important physical effects were taken into account here: Thermocapillary (Marangoni) convection, natural convection as well as the latent heat of melting/solidification phase transition. The Carman-Kozeny equation was used to account for porous media morphology in the solid-liquid transition zone. The ac magnet is located below the welded plate. The externally applied magnetic field is aligned parallel to the plate surface and perpendicular to the welding direction. The investigations were conducted for 20 mm aluminium plates. It is shown that a 70 mT(rms) ac magnetic field is enough to prevent the gravity-driven drop-out of the melt. The results of the calculations are in a good agreement with experimental data for 15 kW fibre laser beam welding of up to 30 mm thick Al-alloy plates.

A NUMERICAL AND EXPERIMENTAL STUDY OF HEAT AND MASS TRANSFER DURING GTA WELDING OF DIFFERENT AUSTENITIC STAINLESS STEELS

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ABSTRACT

Because of the important effects of weld pool convection on properties of resulting weld, a numerical model has been developed to investigate the weldability of stainless steels. In this study, the evolution of temperature and fluid flow during gas tungsten arc (GTA) welding is investigated. The physical model takes into account heat and mass transfer, electric transport and resulting magnetic field, it considers Marangoni force, self-induced electromagnetic force and buoyancy force for the weld pool convection. This model has been implemented in *Code_Saturne®* (CFD open source code developed by EDF R&D) and used to compute the numerical results presented in the present paper. In order to validate the model, experimental weld beads were made with GTA process, considering different welding parameters and different 304L stainless steel sulphur concentrations. Thermal time evolutions were measured at several positions and post mortem macrographies were analyzed to determine the weld pool cross section sizes. After some fitting of surface tension and global heat loss coefficients the computed weld characteristics are in good agreement with corresponding experiments.

DIFFERENT STRATEGIES TO SIMULATE A DEEP PENETRATION WELDING PROCESS

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ABSTRACT

Within the last two decades, the numerical simulation of welding processes has become more important due to an increase in the available computing power. However, due to the complexity of these processes a variety of different phenomena have to be considered, still resulting in a huge demand for spatial and temporal resolution and hence calculation time. Especially for the case of deep penetration laser beam welding, a vast scope of different velocities, ranging from the extraordinarily fast keyhole process to the comparatively slow melt pool dynamics, have to be considered.

In this paper, two different transient simulation approaches for a deep penetration laser beam welding process are discussed. The first describes the laser beam absorption and evaporation process resulting in the evolution of a typical keyhole, while the second model describes the melt pool dynamics and evolution of the resulting weld seam. Both models focus on different key aspects of the welding process and use different modelling techniques (FEM and FVM), dimensions of the model geometries and degrees of complexity. The adaptive time step size defines if the model can be used to simulate a welding process over nearly a second or only a few milliseconds within a maintainable calculation time.

Simulation of heat and fluid flow with the free surface in 3D gas tungsten arc welding

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Abstract. The aim of this paper is to propose a three-dimensional weld pool model for the moving gas tungsten arc welding (GTAW) process, in order to understand the main factors that limit the weld quality and improve the productivity, especially with respect to the welding speed. Simulation is a very powerful tool to help in understanding the physical phenomena in the weld process. A 3D finite element model of heat and fluid flow in weld pool considering free surface of the pool and traveling speed has been developed for the GTAW process. Cast3M software is used to compute all the governing equations. The free surface of the weld pool is calculated by minimizing the total surface energy. The combined effects of surface tension gradient, buoyancy force, arc pressure, arc drag force to drive the fluid flow is included in our model. The deformation of the weld pool surface and the welding speed affect fluid flow, heat flow and thus temperature gradients and molten pool dimensions. Welding trials study is presented to compare our numerical results with macrograph of the molten pool.

NUMERICAL SIMULATION OF ARC AND METAL TRANSFER IN GAS METAL ARC WELDING

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ABSTRACT

The gas metal arc welding process (GMAW) is one of the most common welding processes. Present process modelling is firstly aiming for the increase of the process understanding and secondly for the development of tools to predict the properties of the resulting joint. However, the validity of actual models is still restricted by the high complexity of the process. So far the GMAW models published were either based on a complex model of the arc, neglecting the metal transfer, or combining the arc and the metal transfer models, in which the characteristics of the arc are highly simplified. Both approaches lead to serious disadvantages for the prediction of the process.

In this paper we discuss improved approaches to model the GMAW arc and the metal transfer in a more accurate manner. Therefore a MHD arc model is combined with a 2T sheath model of the non-equilibrium layer near the workpiece, and the applicability of a P1 radiation transport model is proven. Furthermore, a combination of the improved GMAW arc model with a VOF based metal transfer model is described. In the new model, metal evaporation is calculated self consistently. Calculations of the droplet formation and arc temperature distribution are in remarkable agreement with measurements.

MULTIPHYSICS MODELING OF GTAW PROCESS AND EXPERIMENTAL VALIDATION FOR INVESTIGATING THE WELD POOL FORMATION

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ABSTRACT

A 2D-axisymmetric model for the static Gas Tungsten Arc Welding is presented in this paper. The weld pool model was developed by considering the various driving forces in the weld pool convection such as self-induced electromagnetic, surface tension, buoyancy and the arc plasma drag force. It is found that the model can effectively be used for the prediction of weld pool shape and the temperature distribution in the fusion zone. The simulation results show the dependence of the major driving forces in the development of the weld pool geometry and a reasonable comparison with the experimental data for 304 stainless steel. A reliable experimental setup is used for the acquisition and synchronisation of different experimental data.

MODELLING OF THE DROPLET FORMATION PROCESS IN GMA WELDING

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ABSTRACT

The mathematical model of electrode metal droplet formation during GMAW is proposed. The model concerned allows for influence of surface tension, gravitation and Lorentz force upon the droplet. For the calculation of molten metal free surface form the slender jet approximation of Navier-Stokes equations is used. The anode voltage drop is taken into account while calculating the characteristics of electromagnetic field (electric potential, current density, electromagnetic forces). Effect of anode region dimensions on the volume of detached droplets and frequency of its detachment is analyzed.