



Michel Gradeck

Professor

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## Research

LEMMA - Université de Lorraine - CNRS - UMR 7563

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FRANCE

### - Current Research Interests

Since 10 years, I developed researches in **Heat transfer with phase change** and **Fluid dynamics within a Jet, a Spray or a droplet**. I particularly focus my research on **high temperature surfaces (up to 800°C)**, especially for cooling devices in steel industry. Since the surfaces of steel can be more or less rough, I am also interested by studying the **conditions for transition between boiling regimes** and thus I am developing a new experimental set-up aiming at the observation of boiling regimes and their transition using structured surfaces.

Recently, after the Fukushima accident, I am involved in collaborative project founded by AnR and aiming at better understand (1) the cooling of partially damaged nuclear cores during a LOCA (Loss Of Coolant Accident) and (2) how corium is atomized during its interaction with water. For (1), we need to build a new set-up for better understand the mist flow inside a damage core. For (2), we already build another set-up to test the fragmentation of metal droplet in water at low temperature (to avoid any steam explosion).

## Teaching

University of Lorraine - IUT Nancy Brabois, rue du Doyen Urion - CS 90137, 54601  
Villers-lès-Nancy Cedex

- **Main teaching topics:** Mechanical Engineering, Fluid Mechanics, Heat transfer, Mathematics

## Career

1991-1993 PhD at LEMTA  
1993-1994 National Service – Speyer am Rhein, Germany  
1994-1996 PhD at LEMTA (defended on 15/10/1996)  
1996-1997 Postdoc at LEMTA - Teacher Université Henri Poincaré - IUT Nancy Brabois  
09/1997 Associate professor at Université Henri Poincaré – IUT Nancy Brabois  
1998-2000 School manager of Department of Mechanical engineering, IUT Nancy Brabois  
2000-2001 Full researcher at CNRS, School manager of doctoral school “EMMA”  
03/2007 HDR  
01/05 au 31/12/2011 Scientific period at CSI, TU Darmstadt (Germany)  
2011-2013 Nominated at Scientific National Council (CNU62)  
2013 Full professor at University of Lorraine

## Scientific and professional societies membership

SFT, AFM

## Editorial Responsibilities

Reviewer for International Journal of Multiphase Flow, International Journal of Heat and Mass Transfer, Experimental Journal of Heat and Fluid Flow, Physics of Fluids, International Journal of Thermal Science, Mécanique et Industries, AnR

## International cooperation

CSI TU Darmstadt

## Invited lectures

Gradeck M., Cooling hot surface with water jet or sprays, séminaire invited par Pr C. Tropea, march 2011, TU Darmstadt (Allemagne)

Gradeck M., Heat transfer at the wall for Leidenfrost droplet Measurement method and analysis, séminaire invited by Pr A. Sadiki, june 2011, TU Darmstadt (Allemagne)

Gradeck M., Estimation du transfert de chaleur lors de l'impact d'une goutte en situation de Leidenfrost - analyse et méthode, Journée Matériaux et Phénomènes de Transport pour l'Energie, 15 mars 2012 (INIST-CNRS)

Gradeck M., Phénomènes de transferts lors de l'impact de gouttes sur une paroi chaude, séminaire invited by Pr B. Stutz, Université de Savoie-LOCIE, 10 april 2013

Gradeck M., Cooling of high temperature surfaces - Measurement method and analysis, cours (2x1h), summer school on Multiphase Physics, Gdansk, invited by Pr Jacek Pozorski, IMP of Gdansk, juin 2013, Poland

Gradeck M., Liquid droplet interactions with solid wall, Workshop « structuration de surface : procédés de mise en œuvre, applications et enjeux », 1st july 2014, invited by Pr T. Czerwiec (Université de Lorraine, Institut Jean Lamour)

Sabine Denis, Sylvain Devynck, Jean Pierre Bellot, M. Gradeck, Heat Treatment Distortions and Residual Stresses Simulations: Influence of Heat Transfer and Phase Transformations, Invited Keynote lecture, 16-18 juin 2014, 5th International Conference on Thermal Processing Modeling and Computer Simulation

#### Recent archival journal publications

M. Gradeck, A. Kouachi, A. Dani, D. Arnoult and J.L. Boréan, 2006, Experimental and numerical study of the hydraulic jump of an impinging jet on a moving surface, Volume 30, Issue 3, January 2006, Pages 193-201, Experimental Thermal and Fluid Science, DOI: 10.1016/j.expthermflusci.2005.05.006

F.Volle, D.Maillet, M. Gradeck and M.Lebouche, 2008, Semi-analytical inverse heat conduction on a rotating cylinder with Laplace and Fourier transforms, Inverse Problem in Science and Engineering-IPSE-Cambridge, Vol. 16, n°5, 655-674, DOI:10.1080/17415970701198373

F Volle, M Gradeck, A Kouachi, D Maillet, M Lebouché, Inverse Heat Conduction Applied to the Measurement of Heat Fluxes on a Rotating Cylinder: Comparison Between an Analytical and a Numerical Technique, J. Heat Transfer -- August 2008 -- Volume 130, Issue 8, 081302 (8 pages), doi:10.1115/1.2928013

F Volle, D Maillet , M Gradeck , A Kouachi, M Lebouché, Practical application of inverse heat conduction for wall condition estimation on a rotating cylinder, International Journal of Heat and Mass Transfer, Volume 52, Issues 1-2, 15 January 2009, Pages 210-221, DOI: 10.1016/j.ijheatmasstransfer.2008.05.025

M Gradeck, A Kouachi, F Volle, D. Maillet, M Lebouché, J.L. Borean, Boiling curves in relation to quenching of a high temperature moving surface with liquid jet impingement, International Journal of Heat and Mass Transfer, Volume 52, 2009, Pages 1094-1104, DOI: 10.1016/j.ijheatmasstransfer.2008.09.015

M. Gradeck, D. Maillet, F. Lelong, N. Seiler, G. Repetto, Estimation of droplets/wall heat transfer under LOCA conditions in a PWR, La Houille Blanche, n°4, pp. 52-57,2009, DOI: 10.1051/lhb/2009044

M. Gradeck, A. Ouattara, D. Maillet, P. Gardin, M. Lebouché, Heat transfer associated to a hot surface quenched by a jet of oil in water emulsion, Experimental Thermal and Fluid Science (2011), doi:10.1016/j.expthermflusci.2010.07.002

M. Gradeck, A Kouachi, JL Borean, P. Gardin, M. Lebouché, Heat transfer from a hot moving cylinder impinged by a planar subcooled water jet, Int. J. Heat Mass Transfer (2011), doi:10.1016/j.ijheatmasstransfer.2011.07.038

M. Gradeck, J.A. Ouattara, B. Rémy, D. Maillet, Solution of an inverse problem in the Hankel space – infrared thermography applied to a transient cooling flux estimation, Experimental Thermal & Fluid Science, 2011, DOI: 10.1016/j.expthermflusci.2011.08.003

S. Devynck, M. Gradeck, S. Denis, J.P. Bellot, M. Varlez, T. Benard, Cooling of a rotating cylinder by a subcooled planar jet - Influence of the surface velocity on boiling regime, Key Engineering Materials Vols 504-506,pp 1049-1054, 2012, <http://doi:10.4028/www.scientific.net/KEM.504-506,1049>

P. Ruyer, N. Seiler, B. Biton, F. Lelong, F. Secondi, D. Baalbaki, M. Gradeck, Thermal hydraulic across a partially damaged core during the reflood phase of a LOCA, Nuclear Engineering and Design (NED) Journal – 2013, <http://dx.doi.org/10.1016/j.nucengdes.2013.02.026>

- M. Gradeck, N. Seiler, P. Ruyer, D. Maillet, Heat transfer for Leidenfrost drops bouncing onto a hot surface, *Experimental Thermal and Fluid Science* (2012), doi: <http://dx.doi.org/10.1016/j.expthermflusci.2012.10.023>
- P. Dunand, G. Castanet, M. Gradeck, F. Lemoine, D. Maillet, Heat transfer of droplets impinging onto a wall above the Leidenfrost temperature, *C. R. Mécanique* (2013), <http://dx.doi.org/10.1016/j.crme.2012.11.006>
- P. Dunand, G. Castanet, M. Gradeck, D. Maillet, F. Lemoine, Energy balance of droplets impinging onto a wall heated above the Leidenfrost temperature, *International Journal of Heat and Fluid Flow*, Volume 44, December 2013, Pages 170–180, DOI: [10.1016/j.ijheatfluidflow.2013.05.021](http://dx.doi.org/10.1016/j.ijheatfluidflow.2013.05.021)
- B.F.Z. Fagla, M. Gradeck, C. Baravian and M. Lebouche, Modelling rheology of isothermal flow of carboxymethyl-cellulose-alginate suspension in a horizontal conduit, *Journal of Applied Science & Technology*, vol.18 (1-2), 2013.
- B.F.Z. Fagla, M. Gradeck and M. Lebouche, Experiments on rheology of non-Newtonian flow of tylose-alginate suspension through a horizontal complex conduit, *Journal of Applied Science & Technology*, vol.18 (1-2), 2013.
- B.F.Z. Fagla, M. Gradeck, C. Baravian and M. Lebouché, Experimental Study of Heating of the Newtonian Suspensions made of Large Hard Spheres Based on the Glucose & Water Solutions Flowing in a Horizontal Duct, *International Journal of Scientific & Engineering Research*, vol.4 (4), 790-802, 2013.
- S. Devynck, S. Denis, J.P. Bellot, G. Maigrat, M. Varlez, T. Benard, M. Gradeck, Influence of the Impact Angle and the Gravity Direction on Heat Transfer during the Cooling of a Cylinder by a Free Planar Subcooled Impinging Jet, 2013, *Key Engineering Materials* (Volumes 554 - 557), DOI: [10.4028/www.scientific.net/KEM.554-557.1530](http://dx.doi.org/10.4028/www.scientific.net/KEM.554-557.1530)
- A. Labergue, M. Gradeck, F. Lemoine, Comparative Study of the cooling of a hot temperature surface using sprays and liquid jets, *International Journal of Heat and Mass Transfer* (to be published)