PhD Proposals 2015 for China

1. Title: Development of Rheological Laws for Hot Forming of Metallic Materials

Subfield: Mechanical Engineering

Advisor(s):
Prof. Philippe Dal Santo, philippe.dalsanto@ensam.eu
Dr. Eliane Giraud, eliane.giraud@ensam.eu
Laboratory website: http://recherche.angers.ensam.eu/

Short description of possible research topics for a PhD:
Hot forming of metallic materials remains a privileged process in aeronautic and automotive industries. Numerical simulations are commonly used to predict the good manufacturing of a part. However, the good knowledge of the material behavior is primordial. An efficient model must indeed combined thermal, metallurgical and mechanical approaches. The main objective of the PhD will therefore consist in developing a material model for a given aeronautic alloy under thermomechanical conditions similar to those encountered in superplastic or stamping process. The work will thus be divided into three main steps: (i) characterization and modeling of the rheological behavior; (ii) development of a material subroutine to perform numerical simulations with ABAQUS and (iii) validation of the model by elaborating complex parts and by comparing with numerical results.

Required background of the student:
The applicant will have to possess good aptitudes in mechanics of material and numerical simulation. It will be appreciated if he, or she, has got some background in experimentation and metallurgy.

2-3 representative publications of the group:
M. Achouri, G. Germain, P. Dal Santo, D. Saidane. Experimental characterization and numerical modeling of micromechanical damage under different stress states. Materials and Design, 2013, Vol. 50, pp207-222
A. Hor, F. Morel, J-L. Lebrun, G. Germain. An experimental investigation of the behavior of steels over large temperature and strain rate ranges. International Journal of Mechanical Sciences, 2013, Vol. 67, pp108-122
C. Robert, A. Delamézière, P. Dal Santo, J.L. Batoz. Comparison between incremental deformation theory and flow rule to simulate sheet metal forming processes. Journal of Materials Processing Technology, 2012, Vol. 212 (5), pp1123-1131

Application:
Please send your CV and motivation letter by email to the PhD supervisor with copy to your University International Office and to Prof. Ali SIADAT (ali.siadat@ensam.eu) and Yvon VELOT (yvon.velot@ensam.eu).
If selected, you should then apply for scholarship to the Chinese Scholarship Council (CSC) through your University International Office.

2. Title: Optimal control of an Atomic Force Microscope (AFM) for nano-machining applications

Subfield: Control Theory, Nano manufacturing

Advisor(s):
Olivier GIBARU (Professor) – olivier.gibaru@ensam.eu
Stephane THIERY (Assistant Professor) – stephane.thiery@ensam.eu
In collaboration with :
Emmanuel BROUSSEAU (Lecturer – Cardiff University), Associated Advisor of the PhD.
BrousseauE@cardiff.ac.uk
Rhett MAYOR (Associate Professor – Georgia Institute of Technology, Atlanta)
rhett.mayor@me.gatech.edu

Short description of possible research topics for a PhD:
The PhD research program proposed concerns the improvement and optimization of the AFM probe-based nano-machining control.
In this context, the PhD candidate will conduct the following studies:

- Control the XY nano positioning table by CNC (Computer Numerical Command) approach, with a National Instrumental equipment, for a motion freedom. The first step is to define from the CAD model of the desired pattern, the tip path machining trajectories along polynomials splines curves. The second step is to improve the development of the post-processor between the CAD software and the control algorithm, for a higher level of automation.
- Study the influence of strategies for tip trajectories on the efficiency and quality of the obtained patterns when machining at such small scale.
- Reduce machining errors and improve the quality/efficiency of machining, using both the development of a predictive model error, and real-time control methods algorithms based on algebraic approaches. By the predictive model error, corrections of the tip path trajectory could be done by anticipation, and the efficiency of the three axis control could be improved using the real-time control to improve both the precision and the quality of the height profile.

Keywords: AFM Probe based nano machining, optimal control, tip path trajectories, real-time control, CAD/CAM, automation.

Required background of the student:
We expect candidates having good control theory and mathematic skills. Candidate having good skills in programming (C or C++, Labview) will be appreciated.

2-3 representative publications of the group:
[1] E.B. Brousseau, B.Arnal, S.Thiery, E.Nyiri, O.Gibaru, J.R.Mayor, Towards CNC automation in AFM probe-based nano machining, 8th International Conference on MicroManufacturing (ICOMM2013), pp 499-506
[2] E.B. Brousseau, F. Krohs, E. Caillaud, S. Dimov, O. Gibaru, and S.Fatikow, "Development of a novel process chain based on atomic force microscopy scratching for small and medium series production of polymer nano structured components," ASME Trans. Int. J. Mfg. Sci., 2010; 132(3): 030901 (8pp).

Application:
Please send your CV and motivation letter by email to the PhD supervisor with copy to your University International Office and to Prof. Ali SIADAT (ali.siadat@ensam.eu) and Yvon VELOT (yvon.velot@ensam.eu).
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3. Title: Interface Modeling and Contact Detection within Meshless Methods.

Subfield: Applied Mathematics, Mechanical Engineering, Numerical Methods

Advisor(s):

Pr. Philippe Lorong	(philippe.lorong@ensam.eu)	http://pimm.paris.ensam.fr/en/user/8
Dr. Morgan Dal	(morgan.dal@ensam.eu)	http://pimm.paris.ensam.fr/en/user/271
Dr. Eric Monteiro	(eric.monteiro@ensam.eu)	http://pimm.paris.ensam.fr/en/user/269

Short description of possible research topics for a PhD:
Despite relevant progress, numerical simulations involving large deformations and contacts (even self-contact) are still a challenge in computational mechanics due to the detection of the contact, a purely algorithmic task, as well as the lack of a rigorous description of the interfaces during the whole computation. In fact, both reasons are strongly connected through the numerical strategies used to update and discretize the geometry all along the calculations. The proposed research aims at deriving a consistent framework to describe the interfaces/boundaries and to treat the contact problems within meshless methods like C-NEM. A particular attention will be paid to the computational cost in the different implemented schemes. The efficiency and the robustness of the developed framework will be tested on several numerical studies such as forming, cutting process and laser drilling.

Required background of the student:
The candidate should have a strong background in Mechanical Engineering, Numerical Methods or even Applied Mathematics. Although prior knowledge of the French language is not mandatory, spoken and written English proficiency is needed. A strong interest for computation and programming is expected from the successful candidate.

3 representative publications of the group:
- J. T. Liu, S. T. Gu, E. Monteiro & Q. C. He. 2014. “A Versatile Interface Model for Thermal Conduction Phenomena and Its Numerical Implementation by XFEM.” Computational Mechanics 53 (4): 825–43. doi:10.1007/s00466-013-0933-9.
- P. Peyre, L. Berthe, M. Dal, S. Pouzet, P. Sallamand & I. Tomashchuk. 2014. “Generation and Characterization of T40/A5754 Interfaces with Lasers.” Journal of Materials Processing Technology 214 (9): 1946–53.
doi:10.1016/j.jmatprotec.2014.04.019.
- L. Illoul & P. Lorong. 2011. “On Some Aspects of the CNEM Implementation in 3D in Order to Simulate High Speed Machining or Shearing.” Computers & Structures 89 (11–12): 940–58. doi:10.1016/j.compstruc.2011.01.018.

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4. Title: Ductility prediction of metal sheets using the periodic homogenization technique

Laboratory: LEM3 (Laboratoire d'Etude des Microstructures et de Mécanique des Matériaux), UMR CNRS 7239 (http://www.lem3.fr)
Team: Computational Mechanics. Head of the team: Michel POTIER-FERRY.

Advisor(s):
Farid ABED-MERAIM (Professor): Farid.abedmeraim@ensam.eu
Mohamed BEN BETTAIEB (Associate Professor): Mohamed.BenBettaieb@ensam.eu

Short description of possible research topics for a PhD:
The modeling of the mechanical behavior of metal sheets by using multiscale approaches becomes nowadays a very attractive research topic. This modeling requires the formulation of the constitutive equations at the microscopic scale (the single crystal) along with the use of some transition schemes to derive the overall mechanical behavior at the macroscopic scale. This micro-macro modeling has been coupled with several necking criteria, such as the bifurcation approach and the M-K imperfection-based criterion, to predict the ductility limit of the studied metal sheet. In the previous works, the Taylor model and the self-consistent approach have been used as micro-macro schemes to ensure the transition between the microscopic and macroscopic scales. Several recent studies have revealed the important effect of the transition scheme on the modeling of the polycrystalline behavior and thus on the prediction of the ductility limit of metal sheets. Therefore, the aim of the proposed PhD thesis is to use the periodic homogenization technique (Fig. 1) instead of the previous conventional transition schemes. This technique allows us to take into account some effects not sufficiently considered in the previous approaches (the grain position, realistic grain morphology...). This new modeling will be implemented in the commercial finite element software package Abaqus.

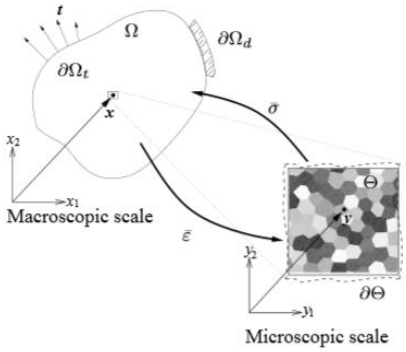

Fig.1. Schematic representation of the micro-macro transition scheme.

Required background of the student: Solid mechanics, computational mechanics

2-3 representative publications of the group:
[1] G. Franz, F. Abed-Meraim, M. Berveiller, "Strain localization analysis for single crystals and polycrystals: Towards microstructure-ductility linkage", International Journal of Plasticity, Volume 48, September 2013, Pages 1-33
[2] G. Franz, F. Abed-Meraim, J-P. Lorrain, T. Ben Zineb, X. Lemoine, M. Berveiller, "Ellipticity loss analysis for tangent moduli deduced from a large strain elastic–plastic self-consistent model", International Journal of Plasticity, Volume 25, Issue 2, February 2009, Pages 205-238
[3] G. Franz, F. Abed-Meraim, T. Ben Zineb, X. Lemoine, M. Berveiller, "Strain localization analysis using a multiscale model", Computational Materials Science, Volume 45, Issue 3, May 2009, Pages 768-773
[4] G. Franz, F. Abed-Meraim, T. Ben Zineb, X. Lemoine, M. Berveiller, "Impact of intragranular microstructure development on ductility limits of multiphase steels", Materials Science and Engineering: A, Volume 528, Issues 10–11, 25 April 2011, Pages 3777-3785
[5] B. Haddag, F. Abed-Meraim, T. Balan, "Strain localization analysis using a large deformation anisotropic elastic–plastic model coupled with damage", International Journal of Plasticity, Volume 25, Issue 10, October 2009, Pages 1970-1996

Application:
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5. Title: Aging of reinforced thermoplastic polymers during service and recycling

Subfield: Chemistry, Polymer and Composites Materials Process and Characterization

Advisor(s): Daniel Froelich, Daniel.froelich@ensam.eu

Short description of possible research topics for a PhD:
Nowadays, the industry is strongly demanding reinforced polymers because of their good performance. The main reasons are economical price and low density that could help to save energy and reduce greenhouse gas emissions. Glass fibers reinforced polymers have many applications in automotive parts (under hood, engine air intake manifold, cooling fan housing, bumper, dashboard), railway industry (train compound, railway tie insulators)

(a)
Bumpers

(b)
Parts of reinforced plastics near engine

But the recyclability of these types of polymers still remains key problem in the recycling of plastics.
The aim of this Ph.D. thesis is developing the recyclability of polyamide 66 and polypropylene glass fibers reinforced and propose a method for recycling these types of composites. A multi-criteria approach will consider the various criteria of recycling between the manufacturing process, the physico-chemical and mechanical characterization, and economic and environmental aspects.
The approach is to focus on the influence of different types of aging such as oxidation and moisture of the matrix, reduced lengths of fiber sizing, mixing effect of additives with different grades, in order to recycling of these materials. The environmental and economic impacts of recycling will be compared to those of the production of new materials in order to determine the environmental benefits of recycling and industrial perspectives.
Required background of the student: Material engineer background with knowledge in polymers and composites materials

2-3 representative publications of the group:

1. Bezati,F., Froelich,D., (2011) « Addition of X-Ray fluorescent tracers into polymers, new technology for automatic sorting of plastics », Resources, Conservation and Recycling, Resources, Conservation and Recycling, Volume 55, Issue 12, October 2011, Pages 1214-1221
2. Froelich, D., Maris, E. (2010) "Sorting Mixed Polyolefins from End-of-Life Product by a Selective Grinding Process »Waste and Biomass Valorization , Vol1, pp. 439-450
3. Bezati, F., Massardier, V., Froelich, D., Maris, E., Balcaen, J.(2010) « Elaboration and Characterization of Traced Polypropylene with Rare Earth Oxides for Automatic Identification and Sorting of End-of-Life Plastics »Waste and Biomass Valorization , Vol 1, pp 357-365

Application:
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6. **Title: Development of Constitutive Models for Accurate Prediction of the Surface Integrity Induced by Machining Aeronautic Materials**

Subfield: Mechanical Engineering

LaBoMaP, Arts et Metiers ParisTech, Campus of Cluny

Advisor(s): J. C. Outeiro, jose.outeiro@ensam.eu

Short description of possible research topics for a PhD:
Metal cutting, or simply machining, is one of the oldest processes for shaping components in the manufacturing industry. It is widely quoted that 15% of the value of all mechanical components manufactured worldwide is derived from machining operations. Efforts on numerical modeling and simulation of metal cutting operations continue to increase due to the growing need for predicting the machining performance, including the surface integrity of machined components (including residual stresses, micro-hardness and microstructural transformations). However, the effectiveness of the numerical simulations to predict the surface integrity highly depends on how accurate are the material (constitutive) models to describe the mechanical behavior of the work material in machining [1, 2].
The objective of this Ph.D project is to develop constitutive (material) models for an accurate prediction of the surface integrity induced by machining aeronautic superalloys (titanium and nickel based). Innovative experimental tests to characterize the mechanical behavior of these materials will be conducted using special designed equipments, able to reproduce identical deformation and thermal conditions as those found in machining. Numerical simulations of these experimental tests will be performed, in order to identify the coefficients of these constitutive models.

Required background of the student:

- A master's degree in mechanical engineering or materials science.
- Ability to work independently, to plan and carry out tasks, and to be a part of a large, dynamical group.
- Good communication skills in English or French, both written and spoken.
- Experience with numerical simulations and programming skills is an advantage but not an exclusion criterion.

2-3 representative publications of the group:

[1] J.C. Outeiro, D. Umbrello, R. M'Saoubi, I.S. Jawahir, "Evaluation of Numerical Models for Predicting Surface Integrity in Metal Cutting", Machining Science and Technology, 2014 (accepted for publication). (http://sam.ensam.eu/handle/10985/8517)
[2] I.S. Jawahir, E. Brinksmeier, R. M"Saoubi, D.K. Aspinwall, J.C. Outeiro, D. Meyer, D. Umbrello, A.D. Jayal, "Surface Integrity in Material Removal Processes: Recent Advances", CIRP Annals - Manufacturing Technology, Keynote Paper, Vol. 60/2, pp. 603-626, 2011.
[3] J.C. Outeiro, J. C. Pina, R. M'Saoubi, F. Pusavec, I. S. Jawahir, "Analysis of Residual Stresses Induced by Dry Turning of Difficult-to-machine Materials", CIRP Annals - Manufacturing Technology, Vol. 57, pp. 77–80, 2008.
[4] D. Umbrello, J. C. Outeiro, R. M´Saoubi, "The Influence of Johnson - Cook Material Constants on Finite Element Simulation of Machining of AISI 316L Steel", International Journal of Machine Tools & Manufacture, Vol. 47, pp. 462–470, 2007.

Application:
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7. Title: Simulations and experiments on two-phase inertial flow in porous media

Subfield: Fluid mechanics, transfer in porous media, numerical analysis, upscaling methods, experiments

Arts et Métiers ParisTech – Bordeaux Campus

Advisor(s):
Azita AHMADI, azita.ahmadi@ensam.eu;
Didier LASSEUX didier.lasseux@ensam.eu

Short description of possible research topics for a PhD:
The general context of the proposed PhD Thesis is the « rapid » flow (non-Darcy regime or inertial flow) of two phases in homogeneous and heterogeneous porous media, the applications of which are found in petroleum recovery and in chemical engineering. The final objective of the present work is to contribute to the development of flow models of two-phase flow in homogeneous media and to compare predictions with experimental data.
The research work proposed consists of:
- carrying out numerical simulations of two-phase inertial flow at the pore-scale in model structures of increasing complexity. The objective of this numerical work is to average pressure and velocity fields in order to determine macroscopic coefficients as they appear in the Darcy-scale model obtained theoretically from upscaling.
- performing laboratory experiments of two-phase flow in micromodels (networks of calibrated channels with typical lengthscale of tens of microns). These experiments aim at a direct comparison with theoretical and numerical approaches.

Required background of the student:
General background in fluid mechanics and transfer phenomena; knowledge of numerical methods and interest in laboratory experiments will be appreciated.

2-3 representative publications of the group:
- Lasseux, D., Ahmadi, A. and Abbasian Arani, A.A., 2008, Two-phase inertial flow in homogeneous porous media: A theoretical derivation of a macroscopic model, Transport in Porous Media, 75(3), 371-400.
- Ahmadi, A., Abbasian Arani, A.A. and Lasseux, D., 2010, Numerical simulation of two-phase inertial flow in heterogeneous porous media, Transport in Porous Media, 84(1), 177-200, DOI: 10.1007/s11242-009-9491-1.
- Lasseux, D., Abbasian Arani, A.A., and Ahmadi, A., 2011, On the stationary macroscopic inertial effects for one phase flow in ordered and disordered porous media, Phys. Fluids, 23(7) 073103, DOI: 10.1063/1.3615514.

Application:
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8. Title: Colloids transport in porous media: Direct numerical simulation at the microscopic scale

Subfield: Fluid mechanics, numerical simulations, physico-chemical interactions, colloid transport in porous media

Arts et Métiers ParisTech – Bordeaux Campus

Advisor(s):
Azita AHMADI, azita.ahmadi@ensam.eu;
Aziz OMARI Abdelaziz.Omari@enscbp.fr
Henri BERTIN h.bertin@i2m.u-bordeaux1.fr

Short description of possible research topics for a PhD:
Natural porous media such as soils or aquifers contain colloidal particles. These particles in suspension in the fluids present in the pore-space can be of different nature (bacteria, clay particles, pollutants …). In the case of aquifers, according to geochemical and hydrodynamic conditions, colloids can be transported by water, develop a high reactivity and a high mobility and act as vehicles to pollutants. Some colloidal particles such as bacteria are also likely to present a risk to the environment and health by altering the quality of drinking water.
Particle transport is also known to be of particular interest in the petroleum industry, since the release and adsorption of natural particles present in reservoirs may alter the petrophysical properties of the porous rocks and lead to additional loss or gain in oil production.
In order to better understand the behavior of colloidal particles in porous media, experimental and numerical studies have been conducted in our laboratory.
Since the behaviour observed during laboratory experiments can not be easily analysed by classical theories, during a recent PhD thesis, a special effort has been put into direct simulation of transport, deposition or detachment of a particle near a rough surface. New numerical modules have been implemented in order to take into account lubrication forces and physicochemical forces between moving particles and rough pore-surfaces. Test cases, chosen on the basis of experimental results presented in the literature, have been limited for the moment to the transport of isolated particles near a solid surface for given hydrodynamic conditions (a given Reynolds number) at different values of ionic strength and the influence of various surface roughness types were analysed.
The objective of this PhD project is to further develop the numerical fluid mechanics code in order to take into account a large number of colloidal particles and carry out a statistical analysis of particle behaviour in porous media. The relative importance of hydrodynamic forces vs physico-chemical interactions on the deposition and release of particles in a pore space for different types of pore-surface roughnesses will be thoroughly analysed.

Required background of the student:
A good knowledge of fluid mechanics and numerical analysis and a real will to invest in direct numerical simulations in fluid mechanics

2-3 representative publications of the group:
- Lopez P., Omari A. and Chauveteau G., Simulation of Surface deposition of colloidal spheres under flow, Colloids and Surfaces A: Physicochemical and Engineering Aspects, 240, 2004, 1-8.
- Canseco V., Djehiche A., Bertin H. & Omari A., Deposition and re-entrainment of model colloids in saturated consolidated porous media: Experimental study, Colloids and Surfaces, A, 352, 2009, 5-11.
- Sefrioui N., Ahmadi A., Omari A. & Bertin H., Numerical simulation of retention and release of colloids in porous media, Colloids and Surfaces A: Physicochemical and Engineering Aspects, 427, 2013, 33-40.

Application:
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9. **Title: Multiple-representations of digital mock-up and its multiple-interactions for enhancing the concurrent engineering in context of product design optimization**

Subfield: Virtual Reality, Augmented Reality, Mech. Eng., Building, Urban planning

Advisor(s):
Frédéric MERIENNE frederic.merienne@ensam.eu
Ruding LOU ruding.lou@ensam.eu
(http://institutimage.fr/index.php?menu=enseignants&lang=en&nomBtn=teatchers)

Short description of possible research topics for a PhD:
Concurrent engineering (CE) is a work methodology that takes into consideration all aspects of the product's lifecycle during the design phases. The CE aims at enabling to reduce this lifecycle by establishing collaboration among all the involved multidisciplinary experts. Nevertheless with the actual computer tools, the experts can neither understand nor interact with (at same place at same time) the unique digital mock-up (DMU) that constitutes an exhaustive representation of a product in its lifecycle. The aims of this PhD topic is using virtual reality (VR) and augmented reality (AR) technologies to enhance the cross-domain interoperability among the experts of different specialties to work together with the DMU in front of them. The VR technologies developed in this research project will use a multiple viewpoints visualization system, a user tracking system and motion capture system to enable the real time multi-representation of the DMU and its multi-interactions according to the expertise of the end-user. New interaction modes will be designed for allowing massive manipulation of models. The scientific issues would be related to the visualization techniques and the interaction modalities enabling the collaboration between the experts. Validation of the proposed solutions would be performed by experimentations.

Figure: DMU in building and urban planning information modelling

Required background of the student:
Computer sciences and computer graphics.
Mechanical engineering.

2-3 representative publications of the group:
- J. Landrieu, Y. Nugraha, C. Pere, F. Merienne, S. Garbaya, C. Nicolle, "Bringing Building Data on Construction Site for Virtual Renovation Works", IJEECS, 1-14, pp.737-747, 2013.
- H. Hrimech, F. Merienne, "Interaction and evaluation tools for collaborative virtual environment", IJIDeM, Springer, 8 March 2010.

Application:
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PhD Proposals 2015 for China

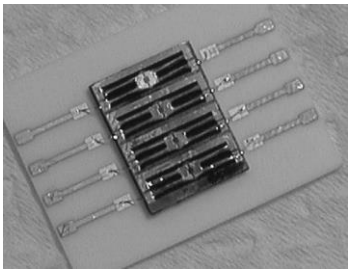
10. Title: Development of shape-memory alloy micro-actuators with integrated closed-loop control

Subfield: Materials Science

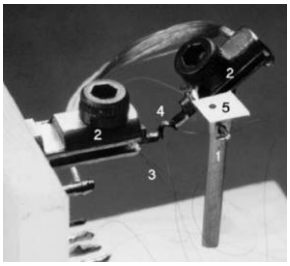
Arts et Métiers ParisTech Metz Campus

Advisor(s):
Julien FAVRE : julien.favre@ensam.eu - http://www.lem3.fr/annuaire.php?page=fiche&nom=Favre

Short description of possible research topics for a PhD:
The aim of this PhD is to develop a new kind of micro-actuator based on the shape-memory effect. Shape memory alloys are a class of smart materials able to create a movement or a force with a change of temperature due to the occurrence of martensitic transformation. These materials are very attractive candidates for the manufacture of small mechanical systems. They can be used for applications in robotics, electronics and biomedical devices. However the development of these active systems is now limited by the lack of control on the displacement. In addition, the maximal frequency of activation is limited by the ability to heat or cool the actuator in a short time.
To solve these two issues, the student will have first to study the microstructure change during the heating and cooling steps of the actuator by microscopy and by DSC. A large part of the study will be dedicated to the establishment of a closed-loop system: some physical parameters related to the martensitic transformation (latent heat, resistivity) will be taken as an indicator of the transformation and used for making a feedback control on the heating or cooling required for a given displacement. In a second hand, systems involving innovative cooling and heating systems will be developed in order to promote the ultra-fast reactivity of the actuator. For instance the use of thermoelectric materials could increase dramatically the cooling step of the actuator, leading to outstanding improvement on the frequency of actuation.



Array of shape-memory actuators



Actuator with thermoelectric cooling elements

Required background of the student:
The selected student must have a good knowledge of engineering sciences, and more especially on applied electronics and physics. Some knowledge on mechanics and finite elements simulation is also required for this project (e.g. Catia, Abaqus or Deform software). The student must have a good ability for experimental work, and enjoying creative and innovative works.

2-3 representative publications of the group:
- Application of Laguerre based adaptive predictive control to Shape Memory Alloy (SMA) Actuator, S. Kannana, C. Giraud-Audine, E. Patoor, ISA Transactions, Volume 52, Issue 4, July 2013, Pages 469–479
- Constitutive model for shape memory alloys including phase transformation, martensitic reorientation and twins accommodation, Y. Chemisky, A. Duval, E. Patoor, T. Ben Zineb, Mechanics of Materials, Volume 43, Issue 7, July 2011, Pages 361–376

Keywords: actuators, electronics, metallurgy, automatism, mechanics

Application:
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11. **Title: Experimental study and modelling of multiphase flow and tracer dispersion in porous and fractured media.**

Subfield: Fluid mechanics in porous and fractured media.

Advisor(s):
Dr. Giovanni RADILLA : giovanni.radilla@ensam.eu - www.researchgate.net/profile/Giovanni_Radilla

Short description of possible research topics for a PhD:
Multiphase flow and tracer transport in porous media and fractures have several industrial applications: chemical engineering, petroleum engineering, hydrology, environmental engineering and geothermal energy production among many others.
Empirical models describing multiphase flow and tracer transport in such media are strongly linked to the media geometric properties (surface roughness, pore-size distribution, pore network connectivity…).
Numerical simulations and experiments are both required in order to build new reliable models and also to find and quantify relevant parameters describing the physics of the flow.
Our expertise focuses on experimental set-ups involving classical pressure and flow measurements combined with image processing techniques which allow to observe different flow regimes and to measure accurately phase saturation under multiphase flow conditions.

Required background of the student:
A solid theoretical and experimental understanding of the fundamentals of fluid mechanics is required. The principles of signal and image processing must be known.
Performing experiments requires dexterity, autonomy and meticulousness.

2-3 representative publications of the group:
Nowamooz A., Radilla G., Fourar M. and Berkowitz B. (2013). Non-Fickian transport in transparent replicas of rough-walled rock fractures. Transport in Porous Media (98)3, pp. 651-682, DOI: 10.1007/s11242-013-0165-7.
Radilla G., Nowamooz A. and Fourar M. (2013). Modeling non-Darcian single- and two-phase flow in transparent replicas of rough-walled rock fractures. Transport in Porous Media (98)2, pp. 401-426, DOI: 10.1007/s11242-013-0150-1.
Radilla G., Sausse J., Fourar M. and Sanjuan B. (2012). Interpreting tracer tests in the enhanced geothermal system (EGS) of Soultz-sous-Forêts using the equivalent stratified medium approach. Geothermics (44), pp. 43– 51. DOI: 10.1016/j.geothermics.2012.07.001.
Radilla G., Kacem M., Lombard J.M. and Fourar M. (2010). Transport properties of Lavoux Limestone at various stages of CO2 like acid-rock alteration. Oil & Gas Science and Technology. DOI: 10.2516/ogst/2009081.
Fourar M. and Radilla G. (2009). Non-Fickian description of tracer transport through heterogeneous porous media. Transport in Porous Media (80)3, pp. 561-579, DOI: 10.1007/s11242-009-9380-7.
Fourar M., Radilla G., Lenormand R. and Moyne C. (2004). On the non-linear behavior of a laminar single-phase flow through two and three-dimensional porous media. Advances in Water Resources (27), pp. 669-677, DOI: 10.1016/j.advwatres.2004.02.021.

Application:
Please send your CV and motivation letter by email to the PhD supervisor with copy to your University International Office and to Prof. Ali SIADAT (ali.siadat@ensam.eu) and Yvon VELOT (yvon.velot@ensam.eu).
If selected, you should then apply for scholarship to the Chinese Scholarship Council (CSC) through your University International Office.

12. **Title: Reduction of multiparametric models in computational electromagnetics for low frequency applications**

Subfield: Electrical Engineering

Arts et Métiers ParisTech Lille Campus

Advisor(s): Stéphane Clénet, (http://l2ep.univ-lille1.fr/)

Short description of possible research topics for a PhD:
To study electrical devices like rotating machines, 3D Finite Element (FE) Models are more and more used. These models are accurate (i.e. virtual prototype) but very time consuming. Consequently, these FE models cannot be used for design except for the last steps of the process. With the recent progress in applied mathematics in multiparametric model order reduction techniques, we can expect to reduce dramatically the time computation of the FE model with an acceptable accuracy loss and so to be able to apply these reduced models in earlier steps of the design in order to speed up the process. The aim of the PhD is to develop and apply model order reduction techniques to 3D FE models of electrical devices. The PhD will be prepared with the research team 'modeling' of L2EP. The developed method will be implemented in the software code_carmel (http://code-carmel.univ-lille1.fr/).

Required background of the student:
Major in Electrical Engineering (Power Electronics, Electrical machines, Power System) with significant backgrounds in scientific programming and numerical analysis

2-3 representative publications of the group:
- Model Order Reduction of Non-Linear Magnetostatic Problems Based on POD and DEI Methods
IEEE Transaction on Magnetics, 2-2014
Thomas HENNERON, Stéphane CLENET
- Model order reduction applied to the numerical study of electrical motor based on POD method taking into account rotation movement
International Journal of Numerical Modelling: Electronic Networks, Devices and Fields, 2-2014
Thomas HENNERON, Stéphane CLENET
- Model order reduction of quasi-static problems based on POD and PGD approaches
EPJ AP, Vol. 64, N°. 2, 10-2013
Thomas HENNERON, Stéphane CLENET

Application:
Please send your CV and motivation letter by email to the PhD supervisor with copy to your University International Office and to Prof. Ali SIADAT (ali.siadat@ensam.eu) and Yvon VELOT (yvon.velot@ensam.eu). If selected, you should then apply for scholarship to the Chinese Scholarship Council (CSC) through your University International Office.

13. Title: Computational design of micro-architectured cellular materials

Subfield: Mechanical Engineering / Materials Science & Engineering

ParisTech Schools: Arts et Métiers-ParisTech & Ponts-ParisTech

Advisor(s):
Dr. Justin Dirrenberger, (justin.dirrenberger@ensam.eu) http://pimm.paris.ensam.fr/en/user/336
Dr. Olivier Baverel (olivier.baverel@enpc.fr) http://navier.enpc.fr/BAVEREL-Olivier
Prof. Gilles Régnier (gilles.regnier@ensam.eu) http://pimm.paris.ensam.fr/fr/user/78

Short description of possible research topics for a PhD:
Micro-architectured cellular materials are an emerging class of advanced materials that bring new possibilities in terms of functional and structural properties. Their improved specific properties are due to a thoughtful topological design. This project consists in developing a computational framework for generating optimised 3D lattice structures for a given set of requirements, e.g. crashworthiness, acoustic damping, etc. This 3D geometry will come as an output from a computational topology-optimisation loop that will be developed around a heuristic generative geometry module, e.g. cellular automata, and a cost function evaluation module, e.g. finite element analysis. That cost function has to be minimised for given constraints in order to obtain an optimised geometry. Selected geometries will then be made using 3D printing (cf. Figure 1), and undergo characterisation.

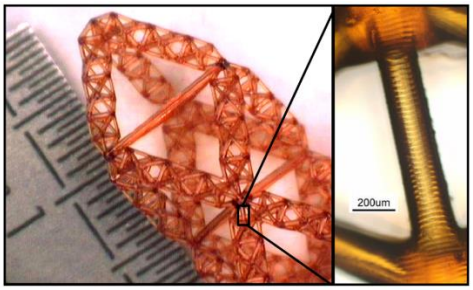

Figure 1 : Example of a 3D printed micro-architectured cellular material

Keywords: Shape optimisation, lattice structures, 3D printing, micro-architectured materials.

Required background of the student:
The candidate should have obtained a Master's degree with a strong background in mechanical engineering, numerical methods or any related field; although prior knowledge of the French language is not mandatory, spoken and written English proficiency is needed. A strong interest for computation and programming and/or scripting is expected from the successful candidate.

3 representative publications of the group:
J. Dirrenberger, S. Forest, D. Jeulin (2012), Elastoplasticity of auxetic materials. Computational Materials Science, 64, pp. 57-61.
J. Dirrenberger, S. Forest, D. Jeulin (2013), Effective elastic properties of auxetic microstructures: anisotropy and structural applications, International Journal of Mechanics and Materials in Design, 9(1), pp. 21-33.
O. Baverel, H. Nooshin, Y. Kuroiwa (2004), Configuration processing of nexorades using genetic algorithms, Journal of the International Association for Shell and Spatial Structures, 45(2), pp.99-108.

Application:
Please send your CV and motivation letter by email to the PhD supervisor with copy to your University International Office and to Prof. Ali SIADAT (ali.siadat@ensam.eu) and Yvon VELOT (yvon.velot@ensam.eu).
If selected, you should then apply for scholarship to the Chinese Scholarship Council (CSC) through your University International Office.

14. Title: Experimental and computational study of fatigue in FCC polycrystals

Subfield: Materials Science & Engineering / Mechanical Engineering

Advisors:
Nicolas Ranc (Nicolas.ranc@ensam.eu) http://pimm.paris.ensam.fr/en/user/9
Justin Dirrenberger, (Justin.dirrenberger@ensam.eu) http://pimm.paris.ensam.fr/en/user/336
Véronique Favier, (veronique.favier@ensam.eu) http://pimm.paris.ensam.fr/en/user/43
Fabienne Grégori (fabienne.gregori@univ-paris13.fr)

Short description of possible research topics for a PhD:
For this research project, both computational and experimental approaches will be considered. Ultrasonic fatigue tests will be carried out on face-centered cubic polycrystals, up to 1011 cycles, a value that could not be attained using conventional fatigue testing. The temperature fields on the specimen surface will be measured and the dissipation fields will be deduced from the heat equation. Before fracture, specimens will be observed through SEM to study signs of plasticity on the surface (persistent slip markings) (cf. Fig. 1). Grain orientations will be also determined using EBSD and will be used for crystal plasticity finite element (CPFE) computations of polycrystalline aggregates in order to further our understanding of the problem; CPFE results will be compared with SEM observations and heat source measurements during the fatigue tests.

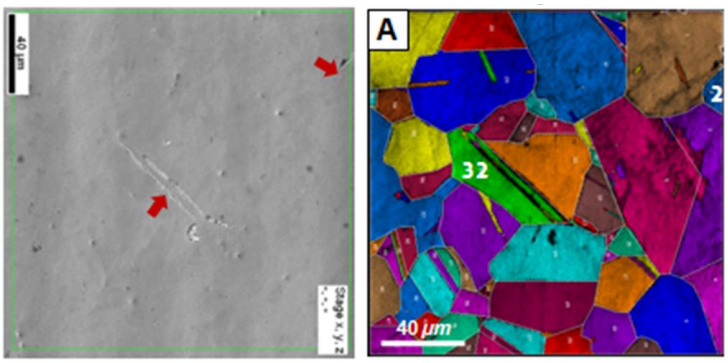

Fig 1. Persistent slip markings observed by SEM, correlated with EBSD grain orientation map (L. Phung thesis)

Required background of the student:
The candidate should have obtained a Master's degree with a strong background in materials science, plasticity, mechanical engineering or any related field; although prior knowledge of the French language is not mandatory, spoken and written English proficiency is needed. A strong interest for both experimental and numerical approaches is expected from the successful candidate.

Representative publications of the group:
N.L. Phung, V. Favier, N. Ranc, F. Valès, H. Mughrabi (2014), Very high cycle fatigue of copper: Evolution, morphology and locations of surface slip markings. Int. Journal of Fatigue, 63, pp. 68-77.
F. Gregori, K. Murakami, B. Bacroix (2014), The influence of microstructural features of individual grains on texture formation by strain-induced boundary migration in non-oriented electrical steels, Journal of Material Science, 49, pp. 1764-1775.
J. Dirrenberger, L. Callen, V. Favier, O. Castelnau (2014), RVE sizes for viscoplastic properties in polycrystalline aggregates, 14th European Mechanics of Materials Conference, Gothenburg, Sweden, 27-29 August 2014.

Application:
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15. Title: Influence of rheological and frictional slip properties on fault mechanics, deformation rates and localization phenomena: exploration with numerical modeling of CRL fault site

Subfield: Applied solid mechanics, Faulting, contact mechanics, viscoplasticity, rock mechanics, geophysics, seismic cycle, earthquake prediction.

Advisors:
Amine Ammar, Professor, Arts et Metiers ParisTech, Angers
Hélène Lyon-Caen, Research Director at CNRS, Ecole Normale Supérieure, Paris
Saber EL AREM, Assistant Professor, Arts et Metiers ParisTech, Angers

Short description of possible research topics for a PhD:
In the last two decades, considerable observational and theoretical work has been devoted to all aspects of earthquake prediction research, for solving fundamental questions concerning the mechanics of fault systems, as well as for answering questions regarding earthquake hazard.
The european natural observatory of the Corinth Rift (http://crlab.eu), a very rapidly deforming area (opening strain rate of ~10-6/yr) where one or more earthquakes with magnitudes above 6 are expected in the coming decades provides a framework in which the mechanics of faults can be studied in details. It is densely instrumented and provides an exceptional data base (seismological, GPS and strain data).
All the prediction approches in the litterature rely on some probalistic description of earthquake generation and timing, through empirical laws guided, or structured, by some simplification of the underlying physical process. This requires that relevant physical models and observational constraints are put at the core of any probabilistic law seismic-hazard assessment. Based on numerical modeling of the CRL region with realistic rheology and fault geometry, our objective is to constrain these key mechanical parameters by improving our ability to model the mechanics of faults in the Corinth Rift as well as their interactions.

Required background of the student:
Continuum Solid Mechanics
Numerical modeling
Computational Mechanics
Spoken and written English, including technical English

2-3 representative publications of the group:
F. Chinesta, A. Ammar, H. Lamari, N. Ranc. Atoms, Molecules and Flows: Recent Advances and New Challenges in their Multi-Scale Numerical Modeling at the Beginning of the Third Millenium. Trends in Engineering Computational Technology, B.H.V. Topping Edt., Saxe-Coburg Publications, Chapter 13 : 247-269, 2008.
Hélène Lyon-Caen, Panayotis Papadimitriou, Anne Deschamps, Pascal Bernard, Kostas Makropoulosb, Francesco Pacchiania “First results of the CRLN seismic network in the western Corinth Rift: evidence for old-fault reactivation”, Comptes Rendus Geoscience, Volume 336, Issues 4–5, March 2004, Pages 343–351
P. Bernarda, H. Lyon-Caen, ... « Seismicity, deformation and seismic hazard in the western rift of Corinth: New insights from the Corinth Rift Laboratory (CRL) »,Tectonophysics, Volume 426, Issues 1–2, 30 October 2006, Pages 7–30
Lambotte, S., Lyon-Caen, H., Bernard, P. , ... « Reassessment of the rifting process in the Western Corinth Rift from relocated seismicity », Geophysical Journal International, Volume 197, Issue 3, 2014, Pages 1822-1844

Application:
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