Job title	**Multi-physics approach for the optimal design of innovative MagnetoCaloric (MC) regenerators (PhD student 2)**
Ref	2018-07-COMPOMAG2
Job type (PhD, Post-doc, Engineer)	Ph.D.
Contract duration (months)	36 months
Qualifications (Master degree, PhD…)	Master degree
Job hour (full time / part time)	Full time
Employer	UBFC – Université de Franche-Comté
Host Laboratory	Institut FEMTO-ST
URL Host Laboratory	www.femto-st.fr
Address Host Laboratory	15b avenue des Montboucons, 25030 Besançon, France
Job description	Introduction : Magnetic refrigeration and heat pumping is a new research domain appeared almost twenty years ago that requires multidisciplinary knowledge in many domains such as physics (magnetism, thermodynamics, fluid mechanics, heat transfers), materials and forming processes. For ten years, the FEMTO-ST Institute has been working on magnetocaloric devices and magnetic materials, and several test benches have been developed in the laboratory's departments. The COMPOMAG project is focused on the manufacturing of thermoplastic highly loaded in MagnetoCaloric (MC) powder in order to obtain MC composite regenerators with specific microstructure on its surface. This structuring at microscopic level (i.e. geometric details at the surface) is required to facilitate the stacking up of the MC regenerator and to enhance the heat transfer and mixing in the fluid boundary layer simultaneously. Moreover, in order to improve dimensional accuracy, the use of finer granulometries of the powders is also required to explore and push the current limits of forming processes and consequently to increase the MC properties. This work will enable the development of innovative nanocomposites with specific functional properties to implement new MC devices that can be used at the end of the project for thermodynamic applications in industrial or domestic cooling and heat pumping. By optimizing the design of the heart of MC machine (performing micro-structured regenerator), it is about allowing the emergence of a low

	cost, environment-friendly industrial refrigeration technology sector, whether in the choice of materials (abundance, economy of rare earth) or in the choice of heat transfer fluids (no greenhouse gases, no ozone depleting power) or in congestion (high power density). In this project, the forming process of materials, the magnetic-dependant thermo-physical characterization of powders and developed components, the optimization based on multiphysics - multiscale analytical and numerical models will be also studied in details. The **COMPOMAG** project includes two PhD students in three different departments of FEMTO-ST located at Besançon and Belfort cities in France. The departements are Applied Mechanics, Micro/Nano Sciences and Systems and Energy. The consortium includes also two companies. The second PhD student, defined as PhD student 2, will develop virtual tools (e.g. by finite element method, scale analysis, semi-analytical modelling, Computational Fluid Dynamics) for the modelling and the optimization of the magnetocaloric regenerators in Active Magnetic Refrigeration cycles using thermofluidic and magnetocaloric simulations combined with knowledge from micro-composite polymer processing and functional properties. The simulations will take into account the couplings between Magnetism, Heat transfers and Fluid Mechanics. Schedule tasks (PhD students 1 & 2) : The work of these two PhD students will include the following major steps: - Elaboration and forming process of the magnetocaloric regenerators (PhD student 1), - Mechanical and thermophysical characterization of materials and regenerators (PhD students 1 & 2). The specific multiphysic characterizations on test samples will be developed (PhD student 2), - Identification of constitutive laws (PhD student 1), developement of multi-physics behavior models and identification of theirs parameters (PhD student 2), - Study of the different multiphysics couplings and of the treatment strategy of them (without coupling, iterative approaches or fully coupled) (PhD students 1 & 2), —Simulations of the nanocomposite forming process (PhD student 1) and of the functional properties (magnetic, magnetocaloric… to be defined) of regenerators with different multiphysics approaches (PhD student 2), - Optimization of the nanocomposite elaboration and forming process (PhD student 1), and of the functional properties (magnetic, magnetocaloric… to be defined) and geometry of regenerators (i.e. dimensions and geometry of its surface) (PhD student 2). - The PhD student 2 will have to work closely in the Energy Department and who are currently developing models and experimental processes related to magnetocaloric material characterization and regenerator performances. - The PhD student 2 will have to synthetize different Python codes in which have been implemented by former PhD students in the different physical domains especially in Energy Department. The developement and the intergration of new behavior laws between the three departements are Applied Mechanics, Micro/Nano Sciences and Systems and Energy will be also realized.

Supervisor(s)	• Yannick BAILLY (Professor, UFC; FEMTO-ST Institute/Energy), supervisor • Thierry BARRIERE (Professor, UFC; FEMTO-ST Institute/Applied mechanics/Besancon), co-supervisor • Stefan GIURGEA (Professor Assistant, UTBM; FEMTO-ST Institute/Energy) • Jean-Claude ROY (Professor Assistant, UFC; FEMTO-ST Institute/Energy) • Laurent HIRSINGER (CR, CNRS; FEMTO-ST Institute/MN2S/Besancon)
Candidate profile	The candidate will be employed by FEMTO-ST and will benefit from the skills and experiences of the laboratory in the fields of mechanics, physics, energy and especially in computational modelings and simulations dedicated to non- linear multi-physics problems and engineering validations. She/he will be involved for simulation and optimization of magnetocaloric regenerators with different multiphysics approaches. Skills in heat transfer and fluid mechanics, multiphysics modelling, material properties, identification is required. The candidate should be qualify in these fields and be motivated by physical modelling, numerical simulations in the set up to magnetocaloric research from theory to applications. A thorough knowledge of English and/or French is required. Experience in programming with Python and/or multiphysic platform, material behavior identification, multi-physic behavior and computational modelling, simulation and software engineering are favourable with an interdisciplinary approach.
Keywords	Fluidic and thermal coupling / Solid-fluid interactions / Computational Fluid Dynamics modeling / Simulation and software engineering / Mechanics of Materials / High-loaded materials / Materials behaviour identification / Magnetism and thermal coupling / Composites / Materials behaviour identification / Magnetic / Python programming.
Application deadline	30 June 2018
Application	Please send the following documents (all in one PDF file) by e-mail to job-application@ubfc.fr: 1) For EU candidates: Copy of your national ID card or of your passport page where your photo is printed. For non-EU candidates: Copy of your passport page where your photo is printed. 2) Curriculum Vitae (1 page). 3) Letter of motivation relatively to the position (1 page). 4) Copy of your Master degree if already available. 5) Copy of your final marks and ranks. 6) Coordinates of reference persons (maximum 3, at least your master thesis supervisor): Title, Name, Organization, e-mail. If you have questions regarding the application, please contact the thesis supervisors and/or the **COMPOMAG** Project manager. Yannick BAILLY (Professor, UFC; FEMTO-ST Institute/Energy), yannick.bailly@univ-fcomte.fr Thierry BARRIERE (Professor, UFC; Institut FEMTO-ST/Applied mechanics/Besancon), thierry.barriere@univ-fomte.fr