IMT Lille Douai
École Mines-Télécom
IMT-Université de Lille

PhD position, TPCIM department,

Institut Mines-Télécom Lille Douai, France

941 rue Charles Bourseul, CS 10838, 59508 Douai

Title: Modelling/ simulation of thermoforming of thermoplastics

Closing date for application: june the 8th, 2018

Industrial context:

Thermoforming is a high-potential process suitable for shaping neat and reinforced thermoplastics to form hollow and open-form parts with complex surface textures of different sizes. From a technological point of view, thermoforming consists in heating a polymer film to conform its shape by using a mold by the action of pressure difference. After cooling the thermoplastic, the obtained part can be extracted. The existing thermoforming technologies cover different industrial sectors such as food and medical packaging and automotive applications (interior cladding, dashboard or door panel cladding). The R&D activities related to these fields aim essentially to achieve the best price-quality compromise by mastering the entire process of thermoforming, reducing the cycle time and minimizing scrap. In most cases (including or excluding any preliminary out-of-plane stretching), the imposed deformations are large, the processing window of temperatures is relatively wide and most importantly temperature distributions are not always homogeneous. Within this context, the development of simulation tools of the thermoforming process, based on relevant material behavior laws and realistic input data, is of major industrial importance.

Scientific context:

The classical thermoforming modelling approaches mostly rely on conventional thermo-mechanical characterization campaigns including shearing, bulging and uniaxial or multi-axial tensile tests, to identify the parameters of predefined phenomenological constitutive laws. However, this approach is confronted to a major difficulty related to the diversity of the real forming conditions which limits the precision of the used constitutive laws to cover the range of real deformations described by the material during thermoforming. In this PhD project, we aim to investigate an alternative approach that relies on whole-field measurements to characterize the behavior of the material "in situ" (during the process). Such approach relies on imaging techniques that track the deformations of the thermoplastic sheet. While the first advantage of this approach is reducing the number of thermo-mechanical characterization tests, the second advantage is to following the deformations of the material under real processing conditions. The combination of both advantages is promising to simulate the variations of the real boundary conditions (thermal and mechanical) experienced by the polymer. However, beyond the simplifying assumptions often accepted at the laboratory scale, in a real environment, synchronizing such full-field characterization techniques with an industrial equipment requires ensuring the validity of the obtained results. For example, during the stretching operation of a thermoplastic sheet by bubble inflation, the material is not only subjected to large deformations over a period of the order of one second but also exhibits out-of-plane geometrical instabilities.

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PhD goals:

The suggested thesis work can be articulated into three main tasks:
1) To identify the appropriate thermo-mechanical constitutive models under homogeneous and controlled thermal boundary conditions, large deformations without or with contact with the mold. Then, to implement the identified models in a FEM simulation code.
2) To constitute a relevant material database for different configurations of interest based on an inverse identification procedure (isotropic, anisotropic, mono or multilayer, resulting from structured mixtures, recycling and / or biosourced).
3) To validate experimentally the numerical results (for example to suggest a geometry of interest of the mold; representative of a simple case of study but multiple deformation states.

Qualifications:

Education/ Background	Holding an engineering or a masters of engineering degree or any equivalent diploma with solid bases in solid mechanics (Preferably in the fields of Materials or Mechanical engineering).
Eligibility	To be graduated no prior than June 2016 with a distinction (14/20)
Interest	Code development using Matlab, numerical simulations, mathematic and experimental skills knowing that the modelling part will be more important than the experimental one.
Disponibility	The contract has to start no later than 1st October 2018 even for candidates ending their studies in June 2018.
Motivation	A good motivation and autonomy are expected during the contract duration
Languages	English: good written and spoken levels are mandatory; French: good spoken level is an advantage, if not you are encouraged to learn it.

Supervision:

Principal supervisor	Marie-France LACRAMPE (Full professor, TPCIM department, IMT Lille Douai)
Co-supervisor	Potential implication of a senior member from the TPCIM department.
TPCIM department	Integration within a team of 15 faculty members, 31 permanent staff and a group of 25 PhD students and post-doctoral researchers.
Doctoral school	*Materials, Radiation and Environmental Sciences*
Conditions	36 months grant contract (social security, health and retirement taken in charge)
Work location	Douai campus : 764, Boulevard Lahure, 59508 Douai, France.

Application:

Motivation letter	What is your career plan? Why interested in a research job?
CV	Provide grades and dates for each year, describe your level in using the finite element method, in solid mechanics, heat transfer, skills in implementing numerical resolution methods …
Referee Coordinates	Give the name of 2 scientists that can give a feedback about your skills.
Selection procedure	Interview, test about understanding of an English article, small code development and basic question on FE

Contacts:

Please submit the required documents (preferably in .pdf format) to the following E-mail addresses:

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