CIFRE PhD POSITION

Shrinkage and warpage prediction of injection molded fiber reinforced thermoplastic parts: optimization of 3D simulation for large parts.

Type of PhD grant: CIFRE (http://www.anrt.asso.fr/fr/espace_cifre/accueil.jsp)

Research field: thermoplastics, natural fibers, injection molding, process experimentation, process simulation, physicochemical and mechanical characterizations.

Context of the research

Injection molded thermoplastic parts can have large deformations due to non-homogenous and anisotropic polymer shrinkages. Therefore an accurate prediction of dimensional properties is very important for industrials. Numerical software are available on the market and these codes aim to simulate the whole process to predict the final warpage of parts. Due to complex polymer rheology, flow-induced crystallization and anisotropic thermo-mechanical behavior, warpage discrepancies between simulation predictions and measurements can be often observed.

This is especially true for large parts as car dashboards produced by Faurecia Company because of the size of the mesh and a more complex melt rheology with polymers reinforced by fillers. It is still more challenging for *Faurecia*, which uses a polymer reinforced by natural fibers having geometrical dispersion and varying mechanical properties.

For these reasons, Faurecia is still using 2D simulations. Even though these simulations can be refitted via tuning parameters, the predictions are not at the expected level by *Faurecia*.

Ph.D. thesis objectives

3D numerical simulations tend to replace 2D part discretization avoiding strong geometrical hypotheses. As *Faurecia* has tested the feasibility of 3D simulations on large dashboard parts (a whole injection simulation on a part discretized in nearly 5.10^6 elements in about 48 hours), it is important for *Faurecia* both to prepare the future mutation and understand the cause of warpage discrepancies between simulations and measurements. Therefore, this research work aims to adapt and optimize natural fiber reinforced polymer characterizations in 3D simulations. A focus will especially be done on solidification kinetic, fiber orientation and viscoelastic behavior in the solid state, which should be identified to better predict stress relaxation in the mold and then shrinkage and warpage. A specific instrumented plate mold will be designed and both 2D and 3D simulations will be compared to assess the precision of prediction or event to refit the material characterisations.

Supervision of the PhD thesis and contact:

Prof. Gilles Régnier (PIMM laboratory at ENSAM Paris) – gilles.regnier@ensam.eu
Dr Jean-Jacques PESCE (Faurecia) - jean-jacques.pesce@faurecia.com