



INJECTION MOULDING OF FIBRE REINFORCED THERMOPLASTICS: INTEGRATION OF FIBRE ORIENTATION AND MECHANICAL PROPERTIES COMPUTATIONS

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Injection moulding is widely used to process short fibre reinforced thermoplastics. The quality and especially the mechanical properties of the resulting part are linked to the mould conception (for example the gate(s) and the venting port(s) locations) and to the processing parameters which will govern fibre orientation distribution.

Fibre orientation modelling is based on the well known Folgar and Tucker equation (1) which differ one from another by the interaction parameter, the closure approximation and by the coupling with the rheology of the reinforced melt. Quantitative comparison with experiments is very tedious and generally limited to simple part geometries (plaque or disk). As a consequence, in complex geometries, fibre orientation distribution is experimentally checked using several techniques and the resulting anisotropic thermomechanical properties are computed using various homogenization theories.

In this paper, we propose an integrated approach of the injection moulding of fibre reinforced thermoplastics starting from rheology of the material, orientation equation, interaction parameter and closure approximation. The resulting local fibre orientation distribution is then used in two ways in order to predict the mechanical properties of the part:

first using classical analytical homogenization theories (2), but based on the computed orientation tensor and not on an experimental one,

then, using numerical homogenization which consists in generating a Representative Elementary Volume (REV), in determining its unidirectional mechanical properties and finally, in computing directly the anisotropic properties of the part (3).

Several examples of these two methods will be presented.

- (1) F.Folgar and C.L.Tucker: *Orientation behaviour of fibres in concentrated suspensions*, *Journal of reinforced Plastics and Composites*, 3, 98-119 (1984)
- (2) T.Mori and K.Tanaka, *Average stress in matrix and average elastic energy of materials with misfitting inclusions*, *Acta Metall* 21,571-574 (1073)
- (3) H.E.Miled, *Modélisation de l'orientation de fibres induite par l'écoulement et comportement thermo-elastique anisotrope à l'état solide*, Thèse de doctorat en mécanique numérique, Mines-Paristech (2010)