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Continuous Cooling Transformation, a Route for Understanding Polymer Solidification under Processing Conditions

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A contribution to the understanding of solidification under processing conditions can be given by a Continuous Cooling Transformation approach (CCT) using cooling rates ranging from 0.1°C/s to above 1000°C/s. The substantial homogeneity of the structure formed renders possible the use of available macroscopic (bulk) methods like density, Wide Angle X-ray Diffraction (WAXD) and Micro Hardness (MH) for its characterization. Sample homogeneity is an important feature representing an evolution with respect to the traditional CCT used in metallurgy and to polymers solidified during processing where a distribution of morphological features is always observed, e.g. the skin core morphology found in many processing routes.
Solidification of long chain polymers from the melt gives systematically rise to the onset of metastability intrinsic in the phases formed or due to low dimensionality of crystalline domains. This requires caution on treating and analyzing samples and it opens new possibilities to study long term stability and embrittlement (ageing).
By this method it is also possible to describe the solidification behavior although the limited physical understanding of crystallization kinetics, only recently recognized to be a multistage process. Once data covering a wide range of operating conditions, typical of polymer processing, are available, even a heuristic model of crystallization kinetics may describe polymer solidification. This is a substantial evolution with respect to common practice which assigns “predictive” potentialities to much the same models albeit based on data obtained on a narrow window of operating conditions, e.g. by DSC or similar standard methods.
In this work the possibilities offered by the technique are discussed with the help of recent results obtained for the characterization of polymer solidification as well as some recent attempts to study structure evolution, i.e. the so called "post processing" behavior.