

# Melting behaviour and ultra-drawability of nascent UHMWPE powder

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The melting behavior of nascent ultra-high molecular weight polyethylene (UHMWPE) powder has recently received considerable attention [1]. It was shown that the elevated first melting peak is due to superheating of the nascent UHMWPE powder [1-3]. The anomalous superheating effect, which is not observed in melt-crystallized UHMWPE, is thought to be due to the special morphology of nascent powder resulting in a high crystallinity and a low degree of entanglement. This special nascent (also called “virgin”) morphology can be achieved by polymerization at relatively mild conditions or by using unsupported single-site catalysts. In both cases, the as-polymerized polymer chain is thought to crystallize before it can entangle with its neighbors.

Reliable characterization methods for the degree of disentanglement are key to steer catalyst selection and polymerization conditions in order to speed up research. The currently used methods include drawability, which is a semi-quantitative method as the drawability is influenced by other factors apart from the level of disentanglement, such as powder morphology, compaction stage and deformation rate and temperature during drawing. Another way of analyzing the nascent powders in term of degree of disentanglement could be through thermal characterization. It is known that nascent polymer materials depict strong superheating and it has been proposed that this correlates with the state of entanglement. Rastogi et al. have observed that UHMWPE reactor powders show slow melting when annealed below the melting temperature [1]. By annealing the powder below the melting point for different annealing times, they found that the higher the level of disentanglement, the faster the complete melting of the powder that is achieved. It is thus believed that the time required for melting upon annealing is related to the level of disentanglement. This hints to different melting kinetics, dependent on the amount of entanglements in the nascent powder

The objective of the current study is to evaluate the level of disentanglement of nascent UHMWPE powder by investigating the kinetics of nascent UHMWPE crystal melting by differential scanning calorimetry (DSC), evaluated in the framework of isoconversional kinetic analysis. Isoconversional analysis is a relatively new method for analyzing thermally stimulated processes such as crystallization and melting [4].

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[2] A. Toda, M. Hikosaka, K. Yamada, “Superheating of the melting kinetics in polymer crystals: A possible nucleation mechanism”, *Polymer*, 43 (2002), 1667-1679

[3] S. Vyazovkin, B. Yancey, K. Walker, “Nucleation -Driven Kinetics of Poly(ethylene terephthalate) Melting”, *Macromolecular Chemistry and Physics*, 214 (2013) 2562-2566

[4] S. Vyazovkin, “Isoconversional Kinetics of Thermally Stimulated Processes”, Springer, 2015