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ABSTRACT:

Sintering of UHMWPE Powders: Is there Really a "Melting Explosion"?

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Ultra high molecular weight polyethylene (UHMWPE) is classically processed by sintering due to very high viscosity. During this process it has been noticed that the required time above the melting temperature to ensure a good bonding of the initial powder particles is strongly weaker than it could be expected considering the reptation theory. De Gennes et al.[1] proposed a mechanism called “melting explosion” to explain this phenomenon. Considering that the nascent powder is composed of very far from equilibrium chains, the melting allows the weakly entangled chains to diffuse very quickly and reentangle in times close to Rouse times. In this paper we try to quantify that time and to elucidate the melting explosion mechanism. In this aim, we have performed ultra fast sintering by adding iron nanoparticle to UHMWPE powders allowing magnetic induction very quick heating. Then mechanical properties as well as microstructure characterisation have been performed to determine the required time to recover the bulk properties. We have evaluated both the viscosity during sintering as well as yield stress and fracture energy after sintering. The times have been found to be higher than the Rouse time (few hundreds) but much lower than the reptation time (10⁴). Finally we have developed a coarse grained molecular dynamic simulation of nascent systems that has allowed to propose a plausible scenario to explain these characteristic times.

[1] De Gennes, P. G. Explosion upon melting. Comptes Rendus Acad. Sci. Ser. II-B 321, 363–365 (1995).