OP-7-533

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INFLUENCE OF MOLECULAR WEIGHT AND VISCOSITY ON PARTICLE COALESCENCE FOR LASER SINTERING OF NYLON-12

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Laser sintering of polymers is an ‘Additive Manufacturing’ technology (previously known as Rapid Prototyping / Manufacturing) that has been developed over the past two decades. The technology has been implemented in a vast range of products and represents a significant growth sector in component design and manufacture.

Sintering kinetics and part reliability are critically dependent on the melt viscosity of materials such as polyamide 12 (PA-12). The purpose of this paper is to characterise the viscosity of PA-12 powders using alternative scientific methods: constrained boundary flows (capillary rheometry) and rotational rheometry. Sintering is a thermally driven process that allows particle coalescence to occur at a rate dependent upon other physical properties such as melting and crystallisation behaviour, surface free energy and melt viscosity. Theoretical viscoelastic models are available to predict particle coalescence based upon properties data, yet these are not fully developed and cannot currently account for the in-process changes in properties that occur. Nylon-12 is the most commonly used material for laser sintering and whilst the creation of mechanically robust parts is possible, the range of mechanical properties is constrained by the behaviour at the processing stage, where changes in molecular structure are known to occur.

Results demonstrate conventional pseudoplastic flow in all PA-12 materials. Zero-shear viscosity has been quantified by rotational rheometry; a notable observation is the striking difference between virgin and used PA-12 powders, which has important implications for laser sintering processes. This has been interpreted in terms of molecular weight and chain structure, possibly arising from polycondensation of PA-12 powders held at the bed temperature during laser sintering. Processing / rheology data will be supported by thermal analysis, GPC data and video footage from hot-stage microscopy (HSM), to verify fundamental approaches to study particle coalescence.