MONITORING PHYSICAL TRANSFORMATIONS ON THE NANOSCALE IN REAL-TIME DURING PHOTO-INITIATED POLYMER NETWORK FORMATION USING X-RAY SCATTERING

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Elucidating nanostructure-property relations is vital for tailoring macroscale properties of functional materials. Hereby, it is essential to observe physical transformations in situ and in real-time during the materials´ processing. Such physical transformations are induced by external stimuli, for example temperature [1] or UV-light in case of photopolymerization [2]. Excellently suited for this task are scattering methods using X-rays and neutrons when applied as analytical methods. Owing to their ability to penetrate into material, complex processing environments mimicking real-world, industrially relevant conditions are incorporated in such investigations. In order to show the tremendous potential of this combination, we will highlight various examples. To start with, we use a model system of polystyrene colloids with chemically different shell to describe the heat-induced morphological changes in such latex films [3]. The kinetics of layer formation and the final nanostructure, e.g. in additive manufacturing, strongly depend on the processing conditions [4]. Towing polymer processing, we elucidate the fundamentals of injection moulding [5], all in combination with scattering methods. Using these examples as basis, we highlight the use of surface-sensitive X-ray scattering to investigate the evolution of heterogeneities in UV-curable resins [6]. We detail the influence of glass transition temperature on the physical transformation during UV curing and relate the final film morphology to the molecular structure. We give an outlook how these advanced analytical techniques will be extended to 3D printing using photopolymerization.

References

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