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Probing Nanoparticle Correlations in Filled Elastomers during Tensile Deformation by SAXS
EDWARD J. KRAMER, ARTHUR K. SCHOLZ, UCSB, ALEXANDER HEXEMER, LBL, HUAN ZHANG, COSTANTINO CRETON, ESPCI-ParisTech — The 2D SAXS pattern from an unstrained 20 wt% nanosilica-filled and crosslinked siloxane elastomer is isotropic and monotonically decreasing with scattering vector q, revealing a fractal aggregate structure of primary silica particles about 10 nm in radius. Under tensile strain along z, the invariant of the SAXS pattern, corrected for the change in sample thickness, is constant, demonstrating the absence of nanovoiding but the pattern itself shows a "2 bar" enhancement of intensity along z at $q^* = 2\pi/<z>$. The distance $<z>$ and peak intensity Ip of the 2 bar pattern increase roughly linearly with extension ratio λ until $\lambda \sim 3$ with $<z>$ saturating and Ip decreasing at higher λs. Reverse Monte Carlo simulations of particle redistribution suggest that the silica aggregates separate into short rafts with compliant polymer in between along z; the extension ratio from $<z>$ of the nearly particle free polymer regions nearly matches λ until $\lambda \sim 3$. For $\lambda > 3$ the rafts begin to break up, providing a partial explanation for the strong Mullins effect above $\lambda = 3$ for this filled elastomer.

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