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Opening and Closing of Nanocavities under Stress in Soft Nanocomposites: A Real Time Small Angle X-ray Scattering (SAXS) Observation HUAN ZHANG, JORDAN DE CREVOISIER, Soft Matter Science and Engineering, ESPCIParisTech-CNRS-UPMC, Paris, France, ARTHUR SCHOLZ, Materials Research Laboratory, UCSB, 93106-5121 CA, U.S.A., FABIEN VION-LOISEL, Michelin, EDWARD J. KRAMER, Departments of Materials and Chemical Engineering, UCSB, 93106-5050, COSTANTINO CRETON, Soft Matter Science and Engineering, ESPCIParisTech-CNRS-UPMC, Paris, France — Cavitation occurring at the nanometer length scale has been recently demonstrated conclusively in rubbers[1]. Real time SAXS with synchrotron radiation is employed to probe the structure changes in carbon black filled styrene-butadiene rubber (SBR) under uniaxial tension. The scattering invariant $Q(\lambda)$, where λ is the extension ratio, increases sharply, which we attribute to void formation, above a critical true stress (~25 MPa) that is roughly independent of both filler content and crosslinking density. During step-cycle tests Q decreases on unloading to Q_0, its value before any testing, and does not increase again until λ exceeds the maximum previous $\lambda = \lambda_{max}$, showing that the voids close upon unloading and only reappear upon reloading when $\lambda > \lambda_{max}$ (Mullins effect). We attribute the increase of the scattering invariant once λ exceeds λ_{max} to the creation of new voids rather than to the reopening of old ones. The scattering of the voids in the region $q < 0.1\ nm^{-1}$ can be separated from that of the carbon black particles and provides information on average void size and shape.

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