Measuring speckle Q-Q correlations

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A sequence of papers has previously been presented on the in-situ combined stress-strain and Xray Photon Correlation Spectroscopy (XPCS) measurements using filled elastomers [1-3]. Here, a new analysis of some of this data is presented in which the systematic shifts of the speckles are analyzed allowing for flow patterns of the particle relaxation in the elastomer can be inferred. This information is obtained from cross-correlations of speckle patterns $\langle I(Q,t)I(Q+\delta Q,t+\delta t)\rangle$.

The samples consisted of an elastomer (Ethylene Propylene Diene Monomer, EPDM, rubber) filled with carbon black (N330) or hydoxylated pyrogenic silica (Aerosil 200, DEGUSSA) [4-6]. In our measurements, the one millimeter thick plates are punched out to the classical dumb-bell shape (width = 4 mm). An example flow pattern is shown in Figure 1.

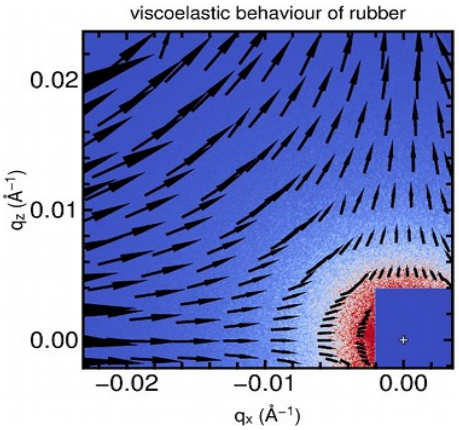

Figure 1: The velocity field of an ethylene-propylene polymer with 16% silica filler, at 60% elongation, 3000s into the stretch. Using coherent xrays, the small angle xray scattering (SAXS) pattern is modulated by a speckle pattern. The deformation of the particle positions under flow leads to a shift in the speckles. The velocity gradient shown is extracted from the change in speckle positions for patterns 10.5s apart. The arrows show that shift scaled by a factor of 200 superimposed on the coherent SAXS pattern. The xray beam was 20 microns by 20 microns in cross section.

References

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