Order and disorder by random crosslinking smectic elastomers

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Soft disorder induced by random crosslinking smectic elastomers [1] provides a new approach to problems of randomness and disorder in condensed matter systems. In many other systems (disordered Ising magnets, superfluid transitions in helium, phase transitions in confined smectic liquid crystals) the disorder is quenched: the source of the distortions is fixed in space and time. In smectic elastomers the crosslinks are not rigidly 'frozen' defects, but consist of flexible chains embedded in the fluctuating system.

Analysis of the x-ray lineshape of the smectic peak indicates that at low density the crosslinks stabilize the quasi-long-range ordering in domains larger than for the homopolymer, while at high concentrations disorder is induced (see Figure 1). Transitions to short-range order are observed as a function of crosslink concentration [2], crosslink stiffness and harmonic number. Some further results on other compounds indicate that also true long-range order can be reached.

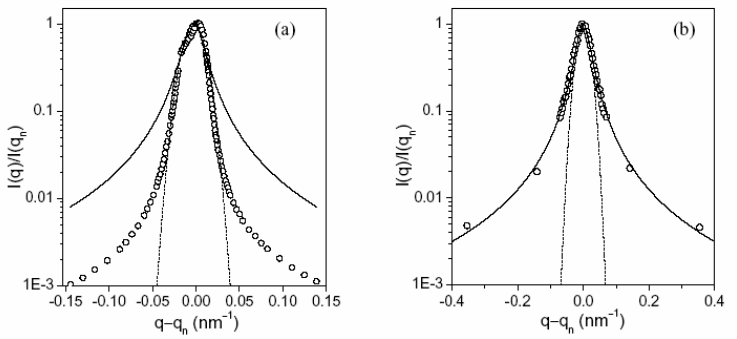

Figure 1: X-ray intensity from the smectic layer periodicity (open circles) for a smectic elastomer with 15% (a) and 20% crosslinks (b), respectively. Dotted line: Gaussian fit, full line: Lorentzian fit. In (a) the results are well described by a Gaussian central part (indicating finite domain sizes) and additional power-law wings, in (b) by a Lorentzian indicating short-range order.

References

[1] M. Warner, E.M. Terentjev, *Liquid Crystal Elastomers* (Clarendon Press, Oxford, 2003)
[2] D.M. Lambreva, B.I Ostrovskii, H. Finkelmann, W.H. de Jeu, Phys. Rev. Lett. **93**, 185702 (2004)