Does a Liquid Occur between the Commensurate and Incommensurate Phases of a Monolayer of Krypton Adsorbed on Graphite?

In a very fine study, Moncton *et al.*[1] observe that near the transition the incommensurate diffraction peak is widened.

They analyze their peaks by fitting them with a Lorentzian $1/[(q-q_0)^2+\kappa^2]$ as for a liquid (the signal-to-noise ratio is hardly sufficient to reject other types of fits). This liquid is required by Coppersmith *et al.*[2] and by Bak.[3]

We think that a more trivial explanation could be given by a dispersion of free adsorption energy due to differences from grain to grain (size, chemical and physical defects, edge effects). This idea has been taken into account on the very same substrate to fit precisely the melting curve of a krypton monolayer[4]; a dispersion of 0.07 K of melting temperature was used in that case.

Consider the formula[1] for the misfit ϵ,

$$\epsilon=\epsilon_0 t^{\beta},$$

with $t=1-T/T_c$, $\beta=\frac{1}{3}$, $\epsilon_0=0.155\ \text{Å}^{-1}$. Far enough from the transition a dispersion δT of transition temperature T_c would give the dispersion of misfit

$$\delta\epsilon=\beta\epsilon_0 t^{\beta-1}\delta t.$$

If we equate $\delta\epsilon$ and the κ used in the Lorentzian, we obtain

$$\epsilon/\kappa=t/(\beta\,\delta t)=(\epsilon/\epsilon_0)^{1/\beta}/(\beta\,\delta t).$$

The curve ϵ/κ vs ϵ of Fig. 4 in Ref. 1 can be fitted for $\epsilon>0.02\ \text{Å}^{-1}$ with $\delta T\simeq 0.6$ K. At smaller misfits, i.e., smaller temperatures, differentials cannot be replaced by the finite dispersion and ϵ/κ should not tend to zero but to about 1, as experimentally found. At still smaller temperatures the commensurate peak should coexist with a widened incommensurate peak over about δT; this fact was observed by Moncton *et al.* over 0.5 K and described as not fully understood.

We mention that we also observed the well-known widening of the incommensurate peak and the decrease of the commensurate peak in a slightly different experiment: At 45 K, we had a 0.1 coverage of xenon and added krypton (after annealing at 90 K). When 0.9 monolayer of krypton was added the commensurate peak diminished before moving or widening clearly. Our substrate was Papyex with coherence length near 350 Å; in that case, the decrease may also be explained by a very small number of walls between commensurate domains in position A, B, or C on graphite. This effect may coexist with dispersion of critical coverage, the extent of which needs more quantitative checks.

A larger dispersion of commensurate-incommensurate transition temperature (0.6 K) than of melting temperature (0.07 K) would mean that the former transition is more sensitive to defects than the latter one, which would not be surprising.

To distinguish between dispersion and real disorder we propose to study the transition on a crystal. This could be eventually done by total-external-reflection Bragg diffraction.[5,6]

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[1]D. E. Moncton, P. W. Stephens, R. J. Birgeneau, P. M. Horn, and G. S. Brown, Phys. Rev. Lett. 46, 1533 (1981).
[2]S. N. Coppersmith, D. S. Fisher, B. I. Halperin, P. A. Lee, and W. F. Brinkman, Phys. Rev. Lett. 46, 549 (1981).
[3]Per Bak, Rep. Prog. Phys. 45, 587 (1982).
[4]R. J. Birgeneau, G. S. Brown, P. M. Horn, D. E. Moncton, and P. W. Stephens, J. Phys. C 14, L49 (1981).
[5]W. C. Marra, P. Eisenberger, and Y. Cho, J. Appl. Phys. 50, 6927 (1979).
[6]P. Eisenberger and W. C. Marra, Phys. Rev. Lett. 46, 1081 (1981).

