4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

Ordered flux-lines lattices in the high-fields mixed state of quasi-2D organic superconductors

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Accepted for publication on 27th May 2015

We have observed ordered flux-lines lattices in layered (quasi 2D) organic superconductors in the virtually unexplored high-fields low-temperatures region of their H-T phase diagram. Exploiting μSR line-shape spectroscopy and its great sensitivity to magnetic flux-lines order, [1,2] we have found clear indications of ordered 3D vortex lattices in the mixed states of the quasi 2D organic superconductors *κ-(ET)$_2$Cu[N(CN)$_2$]Br* and *κ-(ET)$_2$Cu(NCS)$_2$* (*κ-CuNCS*) at *T = 20* mK, under magnetic fields as high as 4 T for the former compound and 3 T for the latter. Furthermore, even at *T = 1* K *we* have observed in the former compound ordered vortex lattices at fields as high as 2 T. This fields range is 2 to 3 orders of magnitude higher than the characteristic field of the crossover from the 3D flux-lines lattice to a multilayer of uncorrelated 2D lattices of pancake vortices, predicted for these compounds by the continuum elastic theory of the vortex lattice. [3] It is also found that the experimentally observed sharp sign change of the μSR line-shape asymmetry (skewness) parameter, associated with the loss of flux-line order, is consistent with melting of pancake vortex lattices within the layers, [4] rather than with a 3D-2D crossover. These observations reflect a robustness of the 3D vortex lattice to thermal fluctuations of pancake vortices in the individual SC layers. We suggest that in the high magnetic field region of the phase diagram investigated, small concentrations of defects that pin flux lines perpendicular to the superconducting layers, effectively resist the breakup of the entire 3D vortex lattice by thermal fluctuations. The primary source of this flux-line pinning may be a consequence of the high rate at which the samples were precooled in our experiments when loaded into the dilution refrigerator.

Keywords:

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