Experimental report

14/05/2024

Proposal: **5-31-2951** **Council:** 10/2022

Title: Ultra High Resolution SANS Study of the IMS Domain Morphology with Transport Current

Research area: Physics

This proposal is a continuation of 5-31-2748

Main proposer: **Xaver BREMS**

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Samples: Nb

Instrument	Requested days	Allocated days	From	To
D33	3	3	12/06/2023	15/06/2023

Abstract:

In Niobium we find due to a rare attractive vortex-vortex interaction the intermediate mixed state (IMS) consisting of flux-free Meissner state domains and mixed state domains. Applying a transport current to a superconductor can induce the flux flow state, where vortices of the mixed state are depinned and start moving orthogonal to the applied current.
In a recent study (Brems 2022 Supercond. Sci. Technol. 35 035003) we observed the current-induced self-organisation of the IMS to stripes oriented orthogonal to the applied current. Due to Amperes law the current is constrained to areas with non-vanishing curl of B, e.g., to the mixed state domains and its interfaces. Given the stripe superstructure, the question that directly arises is how can the current pass across a Meissner domain separating two mixed state stripes? In this detailed follow-up study we want to answer that question using an ultra high resolution setup: By further extending the low-q limit we will be able to resolve the correlation peak of the IMS domain structure and observe the length scales of the IMS domains in horizontal and vertical direction distinguishing between the bridge and perfect stripe scenario.

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The experiment was a success.   We found a novel way to analyse the diffuse Porod scattering to be able to extract length-scales up to 50 microns. The length-scales of the IMS could be matched with Landau's theory. Paper submitted to Superconducting Science and Technology.

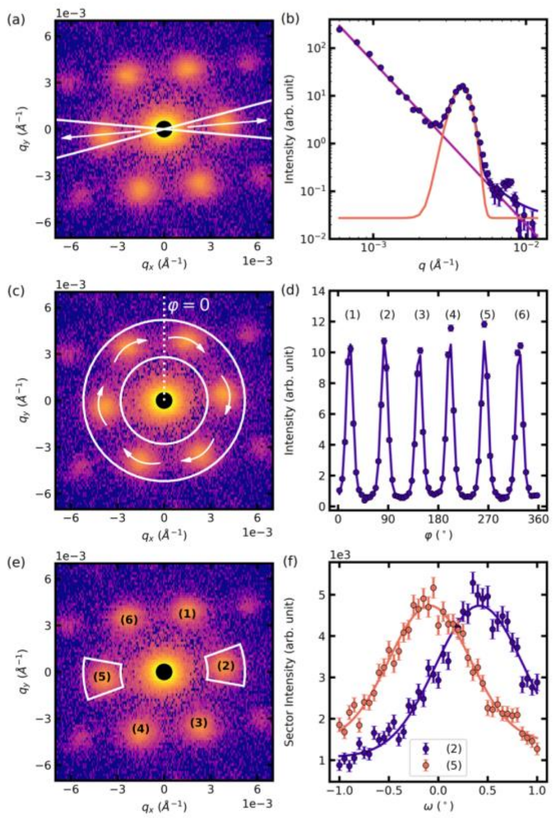

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Fig. 2. From 2D scattering data to 1D reduced data on the example of data measured in B_{app} = 20 mT and T = 4 K. The left panels show the background corrected 2D SANS detector image of the sum of the rocking scan. The rows represent the extraction of the radially averaged data (panels a,b), azimuthally averaged data (panels (c,d)), and rocking curves (panels (e,f)) from the background corrected 2D data to fit the radial, tangential and longitudinal Bragg peak widths, respectively.