Pinning Mode of Wigner Solid in AlAs Quantum Well

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Introduction

AlAs quantum wells of sufficient width have a pair of in-plane anisotropic valleys oriented at right angles to each other. The relative occupation of the valleys can be tuned by uniaxial strain, which can be applied *in situ* by a piezoelectric stack, to the point that the hard and easy axes interchange [1]. It will be of great interest to study the anisotropic Wigner solids in this system in detail. A recent breakthrough [2] in growing devices of this material has resulted in high enough quality that many fractional Quantum Hall States (FQHS) can be observed.

In low disorder GaAs, at the low Landau filling (ν) termination of the series of FQHS, there is an insulating phase that is understood as a pinned Wigner solid (WS), whose signature in microwave spectra is a pinning mode resonance. This resonance is due to pieces of the solid oscillating within the potential of the pinning disorder

Results and discussion

We report microwave spectroscopic study of samples from some of the same AlAs quantum well wafer described in reference [2]. For this preliminary study the sample was not mounted on a piezoelectric stack, and it was patterned with a coplanar waveguide transmission line that was oriented to excite both along the easy and hard directions. Figure 1 shows the results of many spectra as a color map of the real part of the conductivity on the frequency-ν plane. A pinning mode clearly emerges in the low ν insulator; it is the first ever observed in this semiconductor. The pinning mode at least significantly reduced by the 1/5 FQHS, and is probably reentrant around it. The result indicates that the band mass anisotropic WS exists in these samples, and that future studies in which strain is applied are warranted.

References

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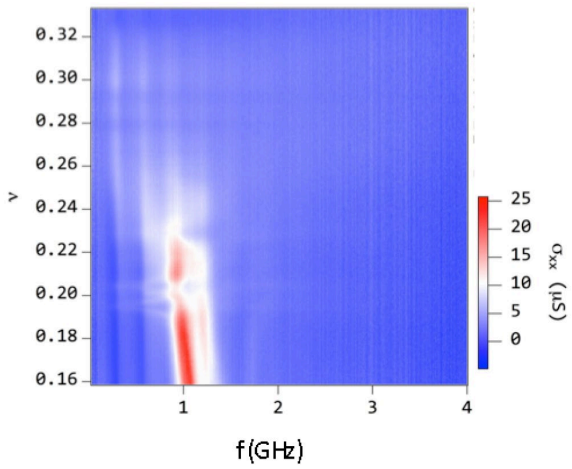

Fig.1 Color map of many spectra taken in high quality AlAs quanrtum well in SCM1. Pinning mode resonance appears as red; other nearly vertical bands are artifacts due to reflections.