FREQUENCY DISPERSION OF THE COMPLEX HIGH-FREQUNCY CONDUCTANCE IN THE *P*-TYPE SI/SIGE HETEROSTRUCTURES IN THE ULTRA-QUANTUM LIMIT. ACOUSTIC STUDY

I.L. Drichko, I.Yu. Smirnov (Ioffe PTI); A.V. Suslov (NHMFL); M. Mironov (Musashi Institute of Technology); O.A. Mironov (NANOTEC); T.E. Whall (Warwick University); Yu.M. Galperin (Ioffe PTI and Oslo University); V.M. Vinokur (Argonne)

Introduction

AC and DC transport measurements in *p*-type Si/SiGe heterostructures with quantum Hall in *the extreme quantum limit* have shown the dielectric behaviors at very low temperatures [1]. Various interpretations of the results, such as the Anderson localization of carriers, the formation of the Wigner crystal or quantized Hall insulator, could be suggested [2]. To discriminate between the electron crystallization and other possible mechanisms one needs to know how the components of the AC conductance depend on a frequency at different magnetic fields and temperatures. Here we report on high field acoustic study of the frequency dispersion of the AC conductance *p*-type Si/SiGe systems.

Experimental and Results

Acoustoelectric effects – the Surface Acoustic Wave (SAW) attenuation coefficient Γ and the relative velocity change ΔV/V have been studied in the frequency range f = 17-150 MHz in the temperature interval 0.3-2.2 K and magnetic fields up to B = 18 T in the heterostructures $Si/Si_{0.95}Ge_{0.05}$ (hole density $p = 8\times10^{10}$ cm^{-2}, mobility $\mu = 1\times10^4$ cm^2/Vs) at different SAW intensities. Fig. 1 illustrates the field dependence of Γ and ΔV/V at different frequencies at T=0.3 K. For relatively low fields Γ and ΔV/V both undergo SdH-type oscillations: the magnetic field position of maxima in ΔV/V and minima in Γ correspond to the center of the ν=1 IQHE plateau observed in DC measurements. In high fields at low temperatures (the extreme quantum limit) both Γ and ΔV/V saturate. By simultaneously measuring Γ and ΔV/V both the real σ_1 and imaginary σ_2 components of the complex conductance $\sigma_{xx}(\omega)=\sigma_1(\omega)-i\sigma_2(\omega)$ [3] were determined as functions of field, temperature, frequency and SAW power. Fig. 2 illustrates the values of the real component of the AC conductivity σ_1 (17MHz) and DC conductivity, which are essentially the same at B < 8T, besides a region near ν=1. Yet at B > 8 T the AC conductance is much larger than the DC one. It was found that in high fields imaginary component σ_2 of the AC conductance is much smaller than real one (see inset of Fig.2). There is weak frequency dependence until 90MHz, then rather sharp increase of the σ_1.

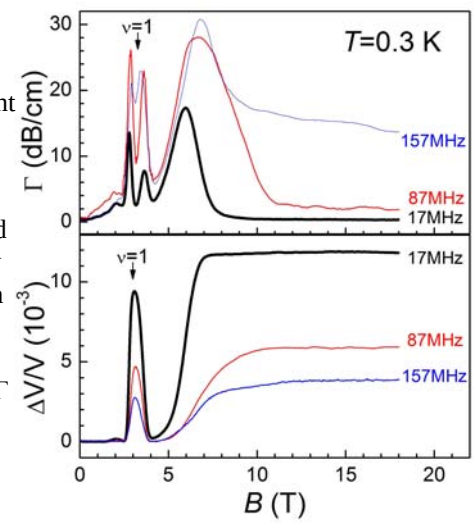

FIG. 1. Field dependence of SAW attenuation Γ and velocity change ΔV/V at different frequences. T=0.3 K.

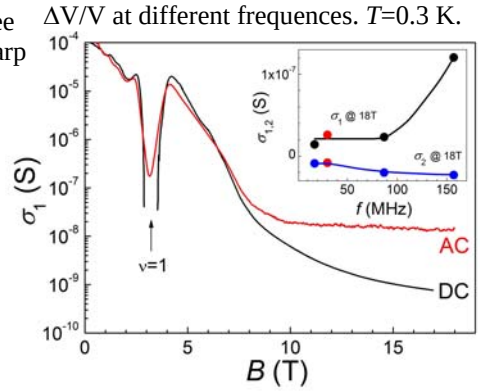

FIG. 2. Dependence of real part of the AC conductivity σ_1 (f=17 MHz) and DC conductivity on B at T=0.3 K. Inset: σ_1 and σ_2 vs f (lines are eye-guided), T=0.3 K, B=18T.

Discussion and Conclusions

The fact that in high fields σ_1 exceeds DC conductance evidence that the hole states are localized. Anderson localization should be, in our view, ruled out as it is associated with a single-hole hopping for which $\sigma_1<\sigma_2$ [3], moreover there should be a strong frequency dependence of σ_1 (~ f) which aren't the case. Thus the effects observed at B>12T, T=0.3-0.8K could be possibly attributed to formation of Wigner crystal.

References

[1] Drichko, I.L., *et al*., Proc. of the 28th ICPS, Vienna, Austria (2006).
[2] Dolgopolov, V.T., *et al*., Phys. Rev. B **46**, 13303 (1992).
[3] Drichko, I.L., *et al*., Phys. Rev. B **62**, 7470 (2000).