MAGNETOCONDUCTANCE OF POLYCRYSTALLINE SILICON IN SemOI-STRUCTURES

A. DRUZHININ[1], I. OSTROVSKII[1], Yu. KHOVERKO[1], K.ROGACKI[2]

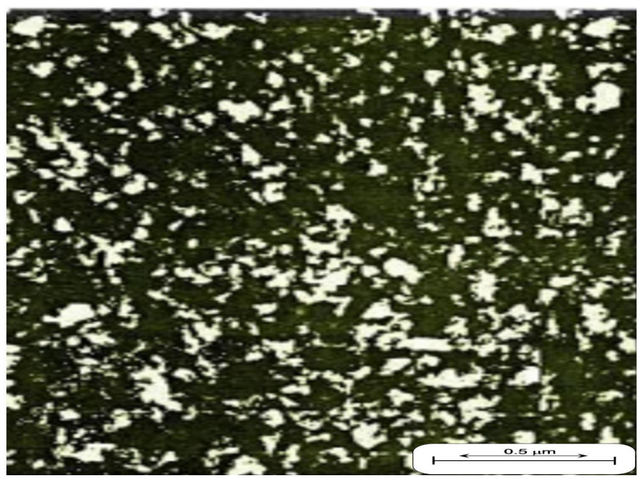
[1]*Lviv Polytechnic National University*

✉ **79013, *Kotlarevsky Str.,1, Lviv, Ukraine,* ☎ (032) 258-21-44, (032) 258-26-27, 💻druzh@polynet.lviv.ua**

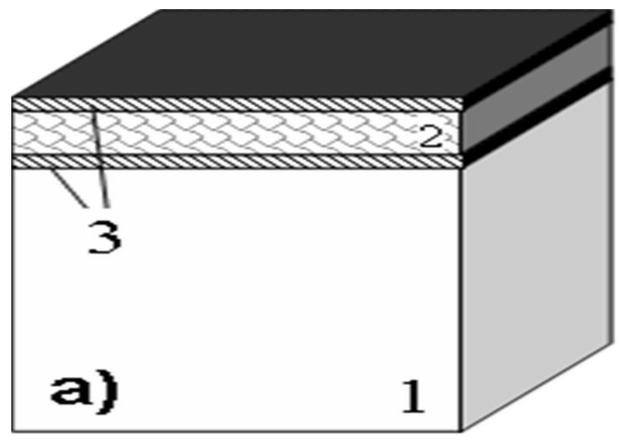
[2]***Institute of Low Temperature and Structure Research PAS,Gajowicka Str., 95, Wroclaw 53-421, Poland***

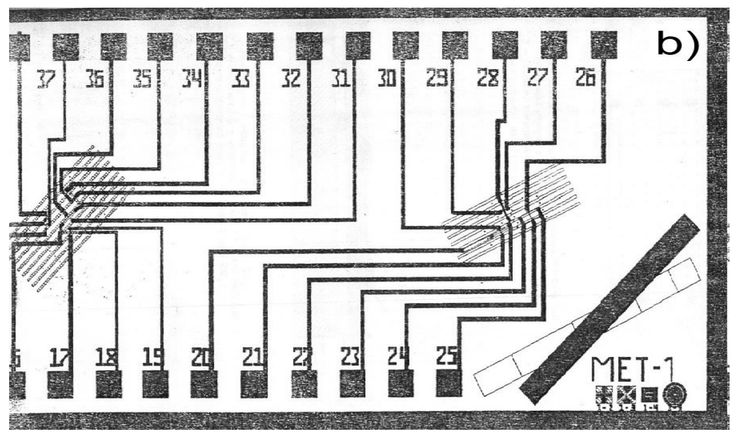
The experimental results of researches of polycrystalline silicon films in SemOI- structures under the influence of magnetic fields up to 14 T at cryogenic temperatures to the temperature of liquefied helium are presented. The concentration of charge carriers in the poly-Si samples according to studies of the Hall coefficient corresponded to values in the range from 7×10^{17} to 1.7×10^{20} cm^{-3}, which covers the metal-dielectric transition for silicon (5×10^{18} cm^{-3}) from the dielectric to the metal side of the transition. The structure and morphology of polycrystalline resistors in samples of SemOI-structures varied from fine-crystalline (about 30 nm) to large-crystalline (about 300 μm) depending on the modes of the laser recrystallization process for homogenization of the material

Object research



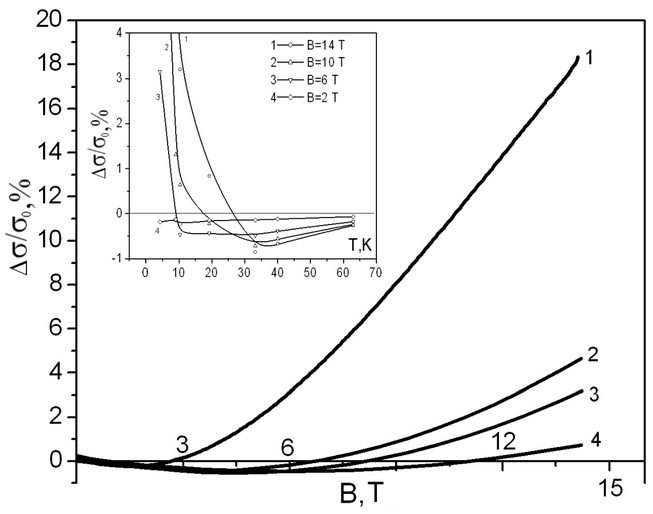
Morphology of experimental samples of polysilicon in SemOI-structures



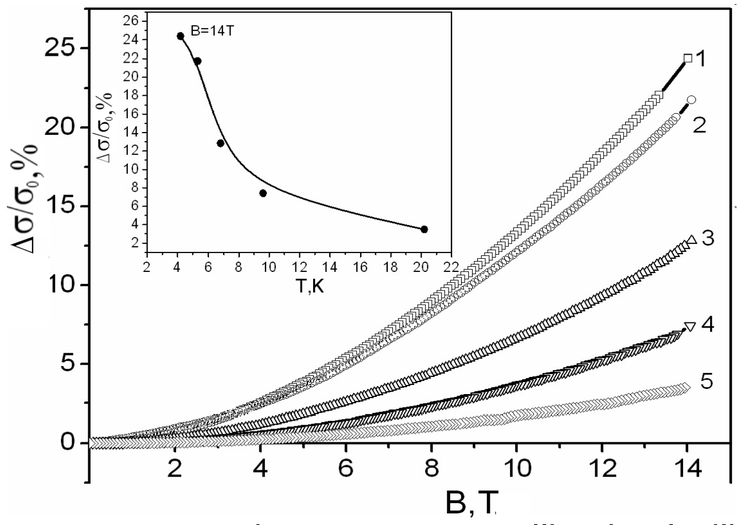


Schematic image (a) and topology of experimental samples of SemOI-structures (b): 1-Si-mono, 2-recrystallized poly-Si, 3 - SiO_2

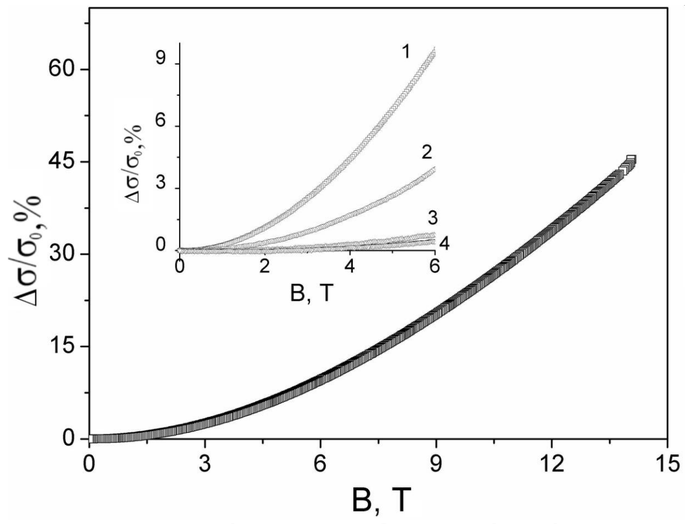
Experimental results



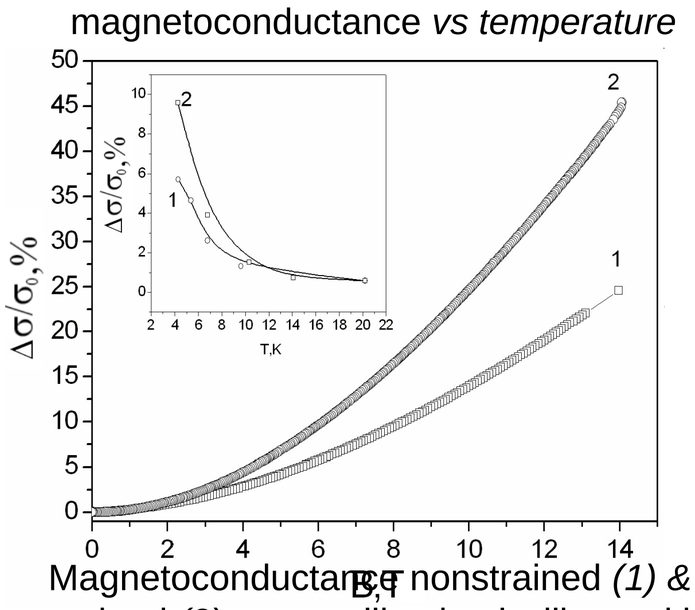
Magnetoconductance nonrecrystallised polysilicon with p_{300K}=2,4×10[18] cm[-3] at different *T* (K): 4,2 (1), 9 (2), 12,3 (3), 19,2 (4). *Inset*: dependence magnetoconductance *vs temperature*



Magnetoconductance recrystallised polysilicon with p_{300K}=4,8×10[18] cm[-3] at different *T* (K): 4,2 (1), 5,3 (2), 6,8(3), 9,6(4), 20,2(5). *Inset*: dependence magnetoconductance *vs temperature*



Magnetoconductance for strained recrystallised polysilicon with p_{300K}=4,8×10[18] cm[-3] at *T*=4,2 K. *Inset*: at different *T* (K): 4,2 (1), 6,7 (2), 14 (3), 20 (4)



Magnetoconductance nonstrained *(1)* & strained *(2)* recrystallised polysilicon with p_{300K} =4,8×10[18] cm[-3] at T=4,2 K; *Inset:* dependence magnetoconductance *vs* temperature in the range *4,2–30 K*

N,cm^{-3}	T,K	g_1, eV×cm^{-3}	g_2, eV×cm^{-3}	a_1, Å	a_2, Å	R_{D^0}, Å	R_{D^-}, Å	ε_{DC}, meV	ε, meV
$2,4\times10^{18}$	4,2-30	$1.3\cdot10^{21}$	$2.0\cdot10^{19}$	6	23	31-36	121-140	1.5	1.9

were *N*- concentration of charge carriers; *T*- temperature; α_1 and α_2- the radius of localization of charge carriers for once and twice occupied centers, R_{Do} and R_{D-} – the length of jump charge carriers for once and twice occupied centers; g_1 and g_2– renormalized densities of states for once and twice occupied centers; ε_{DC} – activation energy of charge carriers, calculated from the experimental data on a direct current; ε – activation energy of charge carriers, obtained directly from the experimental data [1]

$$\frac{1}{R(B)} = \sigma(B) = \Delta\sigma(B) - \sigma(0) = G_0\left[f\left(\frac{B}{H_{so}+H_\varphi}\right) + \frac{1}{2}f\left(\frac{B}{2H_{so}+H_\varphi}\right) - \frac{1}{2}f\left(\frac{B}{H_\varphi}\right)\right] - \sigma(0)$$

Conclutions

To describe the nature of the magnetoconductance of low-alloy recrystallised polysilicon samples with a semiconductor conductivity, we used a model according to which the positive magnetoconductance is explained by quantum magnetoresistance of localized holes due to the magnetic field, in return for negative magnetoresistance characterized by significant spin-orbit interaction.

References

1. Druzhinin A., Ostrovskii I., Khoverko Y., Rogacki K. Rashba interaction in polysilicon layers SemOI-structures // Journal of Electronic Materials.– 48(8).– 2019.– pp.4934–4938