Scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the Academy of Sciences of the USSR (25–26 February 1987)

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A joint scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the USSR Academy of Sciences was held on February 25 and 26, 1987, at the S. I. Vavilov Institute of Physics Problems of the USSR Academy of Sciences. The following reports were presented:

February 25

1. *V. A. Grazhulis.* Low-temperature investigations of surfaces of certain semiconductors.

2. *I. V. Kukushkin and V. B. Timofeev.* Density of states of two-dimensional electrons in a quantizing transverse magnetic field.

February 26

3. *A. G. Vinogradov, A. S. Gurvich, S. S. Kashkarov, Yu. A. Kravtsov, and V. I. Tatarskiĭ.* The backscattering enhancement effect.

4. *A. N. Malakhov, A. V. Polovinkin, and A. I. Saichev.* Partial wave front reversal in a randomly inhomogeneous medium.

5. *L. A. Apresyan and D. V. Vlasov.* Strong double passage effects in laser probing of the upper ocean layer.

Summaries of these reports are published below.

V. A. Grazhulis. *Low-temperature investigations of surfaces of certain semiconductors.* We have addressed the problem of developing experimental methods for studying properties of crystal surfaces in ultrahigh vacuum ($\sim 10^{-10}$–10^{-13} Torr) in the liquid helium to room temperature range.

We report the results of low-temperatures studies of clean (100) surfaces of europium chalcogenides EuO, EuS, EuSe, and EuTe,[1] which are all magnetic semiconductors (Eu^{++} ions are paramagnetic with $S = 7/2$). Clean EuX (100) surfaces were obtained by cleaving the crystals in ultrahigh vacuum. Various experimental techniques were employed: Auger spectroscopy, low-energy electron diffraction, characteristic electron energy loss spectroscopy, and x-ray photoelectron spectroscopy. These are the first data on the atomic structure of the (100) surfaces of the entire class of EuX compounds. We have determined that in the 10–300 K range all EuX compounds exhibit 1×1 unreconstructed (100) surfaces.

The EuTe (100) surface exhibits a new effect: a superstructure incompatible with the bulk spin lattice which appears as the system passes through the Neél temperature $T_N \approx 9.6$ K. We have observed that when the system is cooled through T_N from higher temperatures, the system first exhibits a long-period modulation superstructure which is probably due to the formation of a helical spin configuration near the surface. This modulation superstructure transforms into a stable EuTe (100)–$\sqrt{2}\times\sqrt{2}R$ 45° superstructure at $T < T_N$. We have determined that the superstructure is localized on the surface, as it is destroyed by oxygen adsorption.[2]

We have also studied the properties of Si (111), Ge (111), and InSb (111) surfaces with adsorbed Ag atoms. The absorption temperatures were $T_{ads} = 10$ and 300 K.[3] On the Si (111) surface the thickness of the Ag films was varied in the $\theta = 0$–20 monolayer range.

We have found that at 10 K silver atoms form an amorphous film which practically does not interact with the surface. At $T \sim 100$ K the film begins to form chemical bonds with the substrate. At higher temperatures new surface structures appear in the Si (111) + Ag system. We investigated the properties of these superstructures and found that in the Ge (111) + Ag system the silver atoms are strongly bonded to the Ge (111) surface at temperatures as low as 10 K.

A number of new physical phenomena was discovered on the InSb (110) + Ag surface. In particular, we found that at 10 K and Ag thickness $\theta < 4.5$ monolayers, the silver forms an amorphous film which interacts strongly with the substrate and destroys the substrate's translational symmetry. At $\theta = 4.5$–5 monolayers and $T = 10$ K the InSb (110) + Ag system undergoes a phase transition accompanied by a new crystalline Ag modification of the InSb (110) surface. This is a bcc modification, rather than the expected fcc modification. The "abnormal" silver formation is stable at 300 K. We have established that Ag evaporation onto the InSb (110) surface at 300 K does not lead to a bcc modification—a disordered "liquid" surface results instead. Decreasing the temperature crystallizes the surface and leads to the Ag (110)–1×1 bcc modification. We observe that the InSb (110)–1×1 + Ag (110)–1×1 system has a soft phonon spectrum, which results in a low melting temperature (T_m) and strongly broadened diffraction spots in the low-energy electron diffraction pattern at $T < T_m \sim 100$–200 K. Repeated heating and cooling of the system does not noticeably alter its parameters.

[1] V. A. Grazhulis, A. M. Ionov, V. F. Kuleshov, and A. V. Pokrovskii, Poverkhnost' **5**, 44 (1986) [Phys. Chem. Mech. Surfaces **5** (1986)].

[2] V. A. Grazhulis, A. M. Ionov, and V. F. Kuleshov, Pis'ma Zh. Eksp. Teor. Fiz. **44**, 42 (1986) [JETP Lett. **44**, 52 (1986)].

[3] V. Yu. Aristov, I. L. Bolotin, V. A. Grazhulis, and V. M. Zhilin, Zh. Eksp. Teor. Fiz. **91**, 1411 (1986) [Sov. Phys. JETP **64**, 832 (1986)].

V. Yu. Aristov, I. L. Bolotin, and V. A. Grazhulis, Pis'ma Zh. Eksp. Teor. Fiz. **45**, 49 (1987) [JETP Lett. **45**, 62 (1987)].

V. Yu. Aristov, V. A. Grazhulis, and V. M. Zhilin, Poverkhnost' **6**, 84 (1987) [Phys. Chem. Mech. Surfaces **6** (1987)].

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