Ultra-thin and thin CrSi films on Si(111): II. Transport and magnetic properties

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Abstract: In the first part [N. G. Galkin et al., Ultra-thin and thin CrSi films on Si(111): I. Formation and crystal structure, J. Mater. Chem. C, 2024 (part 1)], structural features of ultra-thin (UT) and thin CrSi films have been considered indicating that the ground state of CrSi is monoclinic but not cubic as previously believed, whereas the grown films consisted of grains with both monoclinic and cubic phases. In this part, we present the results on the transport, magnetotransport, and magnetic properties of UT and thin CrSi films. In the UT CrSi films

(3.19 nm with the predominant contribution of the m-CrSi phase), quantum magnetoresistance with an extremely low magnetoresistive effect (0.025–0.10%) is observed at 2–30 K, but the ordinary and anomalous Hall effects for holes coexist in the temperature range of 40–100 K. The main carriers in the thin (about 31–47.7 nm) CrSi films, consisting of m-CrSi and c-CrSi phases, are revealed to be holes with a concentration of 2.6 × 1022 cm−3 and a mobility of 4.78–4.95 cm2 V−1 s−1. According to the conductivity simulation, 2D-like conductivity is observed for UT monoclinic CrSi films, which is switched to 3D conductivity for thin cubic CrSi films. The UT CrSi films, predominantly exhibiting a monoclinic structure, are characterized by ferromagnetic properties at 3–300 K. According to the magnetic measurements data, the out-of-plane magnetic moment of the m-CrSi film is estimated to be 3.05μB and 1.05μB at 3 and 300 K, respectively, which is in close agreement with the results from ab initio electron structure calculations. The coexistence of c-CrSi and m-CrSi in the form of grains in thin films only leads to a decrease in the saturation of out-of-plane magnetic susceptibility from 1.42μB (at 3 K) to 1.05μB (at 300 K) and in the coercive force.

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