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Autor(en): **Henz, J. / Hugli, J. / Onda, N.**

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ELECTRICAL MEASUREMENTS ON ULTRA-THIN CoSi_2/Si HETEROSTRUCTURES

J. Henz, J. Hugi, N. Onda, H. von Känel, Laboratorium für Festkörperphysik, ETH-Hönggerberg, CH-8093 Zürich, Switzerland

Abstract: The parallel electric transport in ultra-thin ($50\text{\AA}$ - $10\text{\AA}$) epitaxial CoSi_2 layers on $\text{Si}(111)$ has been investigated. We compare the resistivity of buried films, i.e. with $50\text{\AA}$ epitaxial Si on top, versus that of surface layers. The buried films show lower resistivity, which can be explained by a sharper upper interface leading to reduced intersubband scattering.

1. Introduction:

CoSi_2 has the cubic CaF_2 structure with 1.2% lattice mismatch to Si. Using coevaporation of Si and Co [1] we have grown a series of CoSi_2 films on $\text{Si}(111)$ with thicknesses in the range from $10\text{\AA}$ to $50\text{\AA}$. In addition we have grown a $50\text{\AA}$ thick epitaxial Si layer on one half of all samples. Thus for each CoSi_2 thickness we have obtained two different specimens, one without and one with Si on top. By this method we could compare the influence of the surface on the electrical properties of the films.

2. Electric Measurement:

To measure the resistivity we used a six legged bridge, which was defined by mesa-etching, enabling a four point measurement. The temperature dependence of the resistivity $\rho(T)$ showed in every case metallic behavior. In fig. 1) are shown two typical measurements obtained on a $44\text{\AA}$ thick film. The slope of the linear part of $\rho(T)$ is the same with and without Si coverage and it is almost constant down to a layer thickness of $25\text{\AA}$. For the thinnest layers it rises to much higher values in contradiction to [2]. However, the most striking finding is certainly the considerable lowering of the residual resistivity ρ_0 for layers with Si on top (fig. 1). This has been seen for the first time and is in contradiction to results obtained on films grown by solid phase epitaxy [3]. We have to stress that the ρ_0 's are the lowest ever reported for all thicknesses. We therefore conclude, that the quality of the

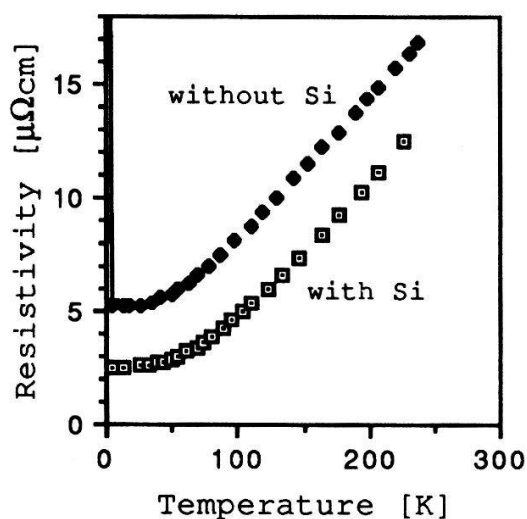


Fig. 1): $\rho(T)$ of a 44 Å thick CoSi_2 layer with and without 50 Å Si on top.

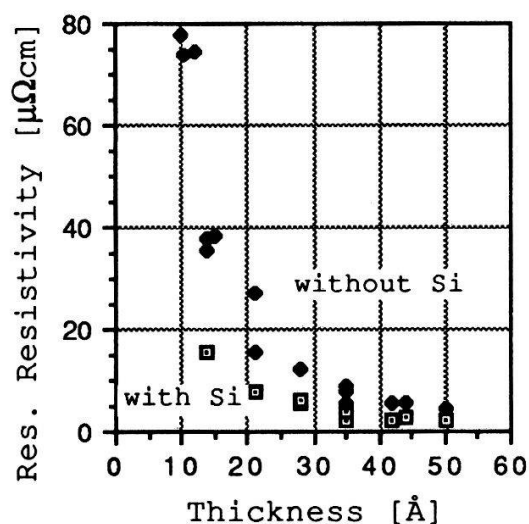


Fig. 2): The residual resistivity in function of the layer thickness.

samples is excellent. In fig. 2) we show the dependence of ρ_0 on layer thickness for the two kinds of samples. We observe that the thinner the samples, the larger the influence of the Si-layer. There are no differences in the carrier density, as Hall measurements indicate, which would explain this behavior. The increase of the resistivity with decreasing CoSi_2 layer thickness can partly be explained by microscopic surface roughness [4]. The lowering of the resistivity with Si on top is due to a sharper upper interface in accordance with TEM results.

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