Epitaxial $YbRh_2Si_2$ films grown by molecular beam epitaxy

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Quantum criticality is in the focus of studies of strongly correlated electron materials. Due to their small and competing energy scales, heavy fermion compounds have played a key role in this research. $YbRh_2Si_2$ is a prototypal quantum critical heavy fermion metal that exhibits a Kondo destruction quantum critical point as its antiferromagnetic phase is fully suppressed by the application of a small magnetic field [1,2,3]. By studying the cubic compound $Ce_3Pd_{20}Si_6$ it was realized that dimensionality is an efficient way to tune through the theoretically suggested [4,5] global phase diagram for antiferromagnetic heavy fermion compounds [6]. Thus, it would be of great interest to tune $YbRh_2Si_2$ towards the extreme 2-dimensional limit. The successful molecular beam epitaxy (MBE) growth of single crystalline thin films of $YbRh_2Si_2$ would provide the unique ability to achieve such tuning. Recent results for $CeIn_3/LaIn_3$ [7], $CeCoIn_5/YbCoIn_5$ [8] and $CeRhIn_5/YbRhIn_5$ [9] superlattices are encouraging and validate our approach.

We have set up an MBE system equipped with a low-temperature evaporation cell for ytterbium and two electron beam evaporators for rhodium and silicon. The $YbRh_2Si_2$ films are grown on germanium substrates due to the low lattice mismatch. The rhodium flux determines the maximum growth rate in our system. We found working growth conditions for $YbRh_2Si_2$ and verified the grown film to have the correct phase by transmission electron microscopy (TEM) diffraction and atomic resolution images (Fig. 1). The chemical characterization was performed by inductively coupled plasma optical emission spectroscopy (ICP-OES) and cross-checked against several other analytical techniques. In addition, electrical resistivity measurements are used to benchmark the film quality.

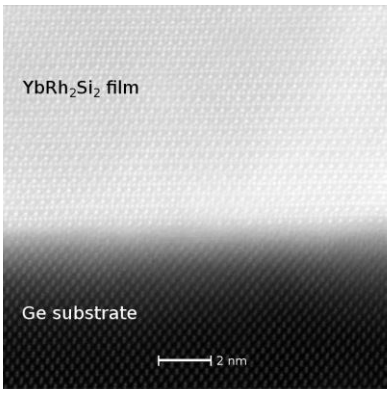

Fig. 1: High resolution TEM image.

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