Thulium atoms and pairs on MgO thin films

investigated by scanning tunneling microscopy and

spectroscopy

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Rare-earth atoms adsorbed on thin MgO films grown on Ag(100) have been widely studied because of their remarkable magnetic stability. The MgO provides a decoupling layer between the adsorbed atom and the metallic substrate, and its thickness can influence the atom electronic properties (1,2,3,4).

In this work, we study thulium (Tm) pairs on bilayer and trilayer MgO on Ag(100) using low-temperature scanning tunneling microscopy and spectroscopy. Tm pairs consist of two atoms separated by a short distance and are different from dimers, which are associated with the first step of cluster formation. On bilayer MgO, pairs are observed in two distinct configurations, symmetric and asymmetric. These configurations can be reversibly transformed into each other by applying a bias voltage above a threshold. The bias polarity and the threshold value depend on the targeted transformation. The transformation can also be induced without tunneling current, showing that the process is field induced. The two pair configurations are characterized by their adsorption sites, orientations, apparent heights, and spectroscopic signatures. Pairs can also be transformed into dimers.

Tm pairs are also observed on trilayer MgO, where the relative stability of the symmetric and asymmetric configurations changes with respect to the bilayer case. Furthermore, the symmetric pair is observed in two non-equivalent orientations with respect to the MgO lattice.

The comparison between bilayer and trilayer MgO allows us to investigate the influence of the MgO thickness on the stability and transformations of the Tm pairs.

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