

Abstract

Magnetic force microscopy having a magnetic probe coated with exchange coupled magnetic multiple layers

A magnetic force microscopy (MFM) probe has an elongated probe tip with a planar surface onto which a uniformly thick magnetic film is formed. The magnetic film may comprise either a seed layer, an exchanged coupled ferromagnetic/anti-ferromagnetic double layer, and a capping layer, or a seed layer, an antiferromagnetic layer, a synthetic triple layer consisting of a thin non-magnetic layer sandwiched by two ferromagnets, and a capping layer. The multiple layers are annealed below the Neel temperature of the anti-ferromagnetic layer and field cooled to establish an unidirectional exchange bias along the tip surface. The coated portion of the tip is made sufficiently long so that the interaction between the tip and sample mainly happens at the bottom end of the tip. The thickness of the thin non-magnetic layer and the two ferromagnetic layers in the synthetic triple layer are chosen such that the two ferromagnetic layers are anti-ferromagnetically coupled, but at the mean time the triple layer as a whole has a net magnetic moment. In both cases, the magnetization of the ferromagnets are strongly stabilized at certain fixed directions and thus, in ideal case, the flux leakage at the middle of the coated portion is negligible; these result in a much higher resolution. As the magnetization is pinned by the exchange coupling mechanism, the total magnetic moment of the tip can be reduced to reduce the undesirable effect of the tip to the specimen.

(Fig. 1)