Magnetic nanostructures

The common driving force for any type of data storage technology is the areal density, provided that the bit-cost performance also improves with the areal density. As a rule of thumb, the bit size shrinks by one order when the areal density increases by two orders. Assuming a square bit, the bit size will be less than 10 nm when the areal density reaches 1 Tbits/in2, which is expected to be realized in 2007. To write information to and read information from these small bits, the write and read heads must have a size which is smaller than or at least comparable to that of the bit. The continuous shrinkage of bit size poses formidable challenges not only to the read heads but also to the recording media. For low-areal density recording, each single bit contains tens of thousands of small magnetic grains. At this level, one will not "feel" the difference when one or two grains are missing. However, the number of grains per bit decreases monotonically with the areal density. This results in an increase of media noise due to the particulate nature of the media. One of the possible ways to suppress the noise is to reduce the grain size of the media so that each bit will contain a greater number of grains. However, this is not so straightforward because the superparamagnetic phenomenon will appear, making the information bit thermally unstable. Although the recent advance in multiple-layered media has greatly enhanced the thermal stability of the media with small grains, it is still far from being a perfect solution. The thermal stability of the media is not only just affected by the grain size, but also very much by the grain size distribution. The latter is technically more challenging because one must use a mass-production technique which can produce not just small grains, but also monodispersed grains. One of the possible ways to realize such a kind of media is to fabricate single-domain particles or dots by using nanofabrication techniques. At ISML, we are currently developing various types of top-down and bottom-up techniques for the fabrication of magnetic nanostructures. In addition to technological applications, we are also interested in fundamental physics of magnetic nanostructures.