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Self-Assembled Growth and Magnetism of Ordered Cluster Arrays

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It is generally recognized that the fabrication of magnetic storage media with bit densities of Gigabytes per square inch and more is out of reach of currently available thin film technologies. Patterned media may therefore set off to challenge thin film media as they allow in principle for bit densities several orders of magnitude larger than what is currently feasible. In this talk I will show how nanoclusters can be fabricated on substrates directly by self-assembled growth, and how their magnetism and their lateral arrangement on the substrate can be controlled. Buffer layer assisted growth is used to form clusters of controlled density and size, in the range between a few atoms to several nanometers diameter. The clusters are randomly distributed over the bare substrate surface. The cluster nucleation on the buffer layer and their growth after making contact with the substrate was studied with variable temperature scanning tunneling microscopy, and will be discussed in the talk. The investigation of the cluster magnetism with X-ray magnetic circular dichroism revealed size and strain effects as well as mutual dipolar and cluster-substrate interactions. We found a pronounced dependence of the magnetic anisotropy on the substrate material. On Pt, for instance, the preferential magnetization direction is out-of-plane, while it is in-plane on Ag. The application of self-assembled clusters as individually addressable magnetic units requires their controlled arrangement into well-defined ordered arrays. We are therefore guiding the clusters with energetic sinks provided by periodic network structures prefabricated on the substrate. We use mechanically extremely stable, electronically insulating boron nitride nanomesh monolayers as template surfaces. Repeated cluster deposition cycles increase the cluster density on the nanomesh, eventually resulting in an densely packed, ordered cluster array with a cluster-cluster distance corresponding to the BN nanomesh periodicity of 3.2 nm. These cluster layers offer densities of magnetic elements as high as 80 x 10^{12} clusters per square inch.