Vertically Aligned Ni Magnetic Nanowires Fabricated by Di-Block Co-Polymer Directed, Al Thin Film Anodization

Researcher:  *Kevin (Kunbae) Noh*, Graduate Student, CMRR and MAE Dept.

Collaborators:  *Edward Choi*, Postdoctoral researcher, CMRR and MAE Dept.
*Stanley Kim*, Graduate Student, CMRR and MAE Dept.
*Leon Chen*, Research scientist, CMRR and MAE dept.

Advisor:  *Sungho Jin*, Professor, CMRR and MAE Dept.

Anodized aluminum oxide (AAO) has been one of the most popular templates for nano-arrayed materials such as nanodots, nanowires, and nanotubes. Self-ordered hexagonal AAO pore arrays have been appealing to multi-disciplinary researchers for various advanced device applications. However, one of the major obstacles so far in using AAO nanotemplates for electronic or magnetic applications has been a difficulty in integrating with other substrates, e.g. Si. Well-ordered AAO is not easily obtained from deposited Al thin films since the pore ordering process often requires initial a few tens of micrometer thick Al materials to be etched away as a sacrificial material until AAO pores could be well ordered. Such a thick Al film deposition also leads to undesirably rough surface geometry. Various pre-patterning techniques have been demonstrated to guide AAO pore formation at specific locations to minimize Al consumption and to explore wider range of AAO nano dimensions. However, the usefulness of such pre-patterning is limited to the cases of typically larger pore size of a few hundred nanometers or to a generally small patterned area due to the time-consuming lithography processing steps.

Here, we demonstrate AAO pore arrays made by Al thin film anodization directed by di-block copolymer (DBCP) whose pore size and interpore distance are 22nm and 48nm, respectively. To guide AAO pores at specific locations, the Al film is pre-patterned by reactive ion etch (RIE) using a DBCP with a vertical and periodic nanopore array as a nano-mask. Using a self-ordered hexagonal pore array in DBCP, subsequent anodization resulted in vertical pore AAO arrays having a high aspect ratio (pore length to diameter). Electrochemical deposition of Ni into AAO pores gives rise to vertically and hexagonally arranged Ni nanowires integrated onto Si substrate. In this presentation, we will describe such a nanotemplate fabrication process on Si and discuss in-plane and out-of-plane magnetic hysteresis loop behavior of Ni nanowire arrays. Such a substrate-based process could be useful for fabrication of extremely small diameter magnetic nanowires of various compositions having magnetically hard, soft or bar-code characteristics for a variety of sensor, actuator or memory applications.