Templates and multilayer electrodeposition towards nanostructures for spin electronics

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Overview – using alumite templates to grow nanowires for magnetotransport studies

Template synthesis

Multilayered nanowires with high interface and compositional modulations

Experimental

- Electrolyte: FeCoNi/Cu bath
- ML ECD mode: potential (E) control, 50 bilayers
- Conditions: 3-electrode cell, SCE, vertical placed electrode, PAR273A
- Substrate: n-Si (100)
- Electrochemical analysis
- Magnetic measurement: 4-point probe geometry GMR, both transverse (T-MR) and longitudinal (L-MR); VSM
- Chemical/structural characterization: EDX, SEM, AFM, XRD, XPS

Multilayer ECD: Effects of [Fe2+] – dissolution analysis, composition and GMR

Sublayer thickness dependence and schematic view of the microstructural features

Conclusions

- Electrodeposition of FeCoNi/Cu multilayer process has been optimized (especially on Ecu), from the viewpoint of less FM sublayer dissolution during potential transition to Ecu, where the optimal interface quality should be obtained
- Low field sensitive GMR can be obtained, with proper bath chemistry, deposition potential and sublayer thickness
- In FeCoNi/Cu ML systems, dissolution during E transition focuses on Fe in FM layer and the interior of the film
- The amount of Fe2+ addition in electrolyte has important influences on the ML physical and functional properties, e.g. composition, dissolution, roughness, MR, Hc and sensitivity
- A sufficiently thick FM sublayer (3-4 nm) and Cu spacer (4-6 nm) is needed to obtain high MR at low field
- Maximum MR above 9% can be obtained, however maximum sensitivity of 0.11 %Oe was obtained with MR about 6.1% and Hc about 40 Oe.
- This work provides a reliable starting point for further ECD MLs in alumite for multilayered nanowire purposes

Current objective - electrodeposition (ECD) and GMR of FeCoNi/Cu multilayers

- ECD FM/Cu multilayers: a promising low cost means for GMR sensors, with special advantages in nanostructured forms.
- High GMR and sensitivity in CIP (current in plane) form: a prerequisite for CPP-GMR (current perpendicular to plane).

ECD Co/Cu multilayers

ECD FeCoNi/Cu multilayers

With proper optimization of growth conditions, possibly higher GMR and sensitivity at low field for FeCoNi/Cu MLs

Multilayer ECD: Effects of Ecu – topography, composition and GMR

Pulsed electrodeposition and dissolution analysis

Status – template and nanowire synthesis

Current density (mA/cm²)