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Selective Etching of Magnetic Layer Using CO/NH_3 in an ICP Etching System

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Magnetic random access memory (MRAM) has made a prominent progress in memory performance and has brought a bright prospect for the next generation nonvolatile memory technologies due to its excellent advantages. Dry etching process of magnetic thin films is one of the important issues for the magnetic devices such as magnetic tunneling junctions (MTJs) based MRAM. CoFeB is a well-known soft ferromagnetic material, of particular interest for magnetic tunnel junctions (MTJs) and other devices based on tunneling magneto-resistance (TMR), such as spin-transfer-torque MRAM. One particular example is the CoFeB - MgO - CoFeB system, which has already been integrated in MRAM. In all of these applications, knowledge of control over the etching properties of CoFeB is crucial. Recently, transferring the pattern by using milling is a commonly used, although the redeposition of back-sputtered etch products on the sidewalls and the low etch rate of this method are main disadvantages. So the other method which has reported about much higher etch rates of>50Å/s for magnetic multi-layer structures using Cl_2/Ar plasmas is proposed. However, the chlorinated etch residues on the sidewalls of the etched features tend to severely corrode the magnetic material. Besides avoiding corrosion, during etching facets format the sidewalls of the mask due to physical sputtering of the mask material.

Therefore, in this work, magnetic material such as CoFeB was etched in an ICP etching system using the gases which can be expected to form volatile metallo-organic compounds. As the gases, carbon monoxide (CO) and ammonia (NH_3) were used as etching gases to form carbonyl volatiles, and the etched features of CoFeB thin films under by Ta masking material were observed with electron microscopy to confirm etched resolution. And the etch conditions such as bias power, gas combination flow, process pressure, and source power were varied to find out and control the properties of magnetic layer during the process.