Ion Beam Etching : a solution for microsystem device processing

Anthony De Luca[a], J. Guerrero and S. Barnola[a]

[a] *CEA-Leti, Minatec, 17 rue des Martyrs, F-38054 Grenoble, Cedex 9*

Abstract

For many years integrated circuits and microstructure devices fabrication to get smaller features in order to achieve higher density has been a challenge with lithography and dry plasma etching technology improvements. Now, the fabrication of new microsystems needs the introduction of materials (like Pt, Ni, Mn, Fe, Co, etc …) incompatible with stand plasma etching. Leading to new stringent etch requirement, the Ion Beam Etching Process enables to address these technological issues.

In this paper, the ion beam milling process is not presented as a simple technological step after lithography and before stripping steps. We will discuss about a complete technological step including lithography, etching and stripping. All the applications presented need metallic compounds or metallic alloys stack etching for microsystem applications. We will be presenting here two cases: stacks which allow hard mask as silicon oxide for etching in device integration and stacks which should be processed with a photoresist mask removed after engraving step. Standard plasma reactor processing temperatures are not compatible with the production of fowl species with these stacks. Today, the ion beam milling offer solutions compatible with such devices processing thermal budgets. Ferromagnetic compound need high temperature plasma etching processes and additional inert gas to help removing non volatile species produce during dry etch process. Due to these non-compatibility, the ion beam milling seems to be the most acceptable solution available today. It's an ambient temperature process which only consists in sputtering of material layer.

The first case is a thick metallic compounds or metallic alloys stack etching for microsystem applications (ie more than 400 nm). Figure 1 shows ferromagnetic multilayer shape after Ar ion beam milling. A study of the hard mask thickness optimization, the importance of sputtering parameters and the capability of such a tool to limit the trenching effect, material redeposit and ion beam enlarging design effect at the edge of the pattern will be presented in this paper.

The second case is a stack of metallic and non-metallic layers where device integration needs a photoresist layer as mask for device patterning. A complete study of photoresist preparation and stripping is there presented. Some specific cases were also treated and solutions will be discussed around photoresist with or without post-treatment and induced stripping solutions.

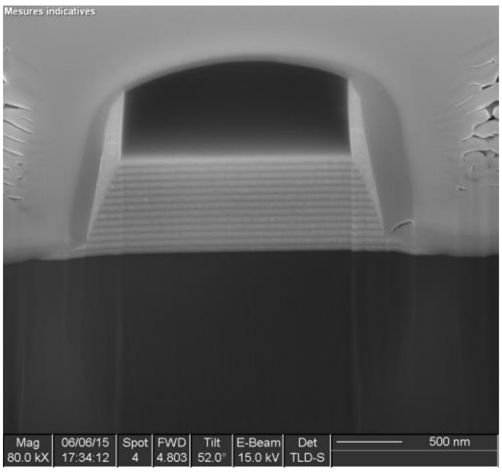

Figure 1: Ion beam milling of a thick stack with silicon oxide hard mask.

**corresponding author e-mail:* anthony.deluca@cea.fr

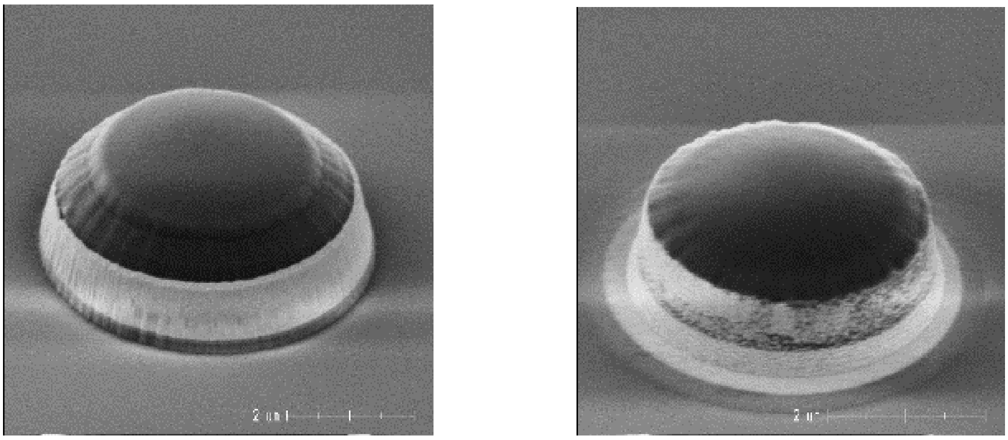

Figure 2: Impact of ion beam angle on wall formation due to material redeposit : process done with a photoresist patterning mask (a) process with a beam angle of 5° process (b) same process with a beam angle of 35°.

**corresponding author e-mail:* anthony.deluca@cea.fr