Applications of XeF2 Chemistry with Focused Ion Beam

Jason Huang

Carl Zeiss NTS, LLC. One Corporation Way, Peabody, MA 01960

Xenodifluoride (XeF2) has been widely used as a source of fluorine, in conjunction with the activation of Ga ion beam, for various materials modification applications, most notably the selective etching of Si over SiO2 or metals. Such selective etching has been commonly exploited by Focused Ion Beam (FIB) users in circuit editing and failure analysis of semiconductor devices. This paper will present results of applying XeF2 chemistry with FIB on several new areas in materials science.

The category of applications of XeF2-enhanced etching with FIB is large volume removal of hard materials. Four examples will be presented: Si, SiO2 (quartz), Alumina, and Shale Rocks. While Si is not necessarily qualified as hard materials, fast removal rate of Si could benefit applications such as back-side etching, or analysis of Through Silicon Vias. The effect of beam scanning parameters and ion beam energy is discussed;

The second category of applications of XeF2 with FIB is large volume removal of metals. One example is presented here: etching of tungsten, which is widely used as interconnection materials in Through Silicon Vias architecture. Rapid removal of tungsten could benefit the throughput of the failure analysis of such structures.

The last category of applications of XeF2 with FIB presented here is related to using XeF2 to assist milling of Ga-sensitive materials. It's well known that there are several materials reactive to Ga, mostly containing In and Sn, and milling artifacts are manifested as a result of the reactions. Three examples will be presented here: GaAs, InSb and CuInGaSe (CIGS). It will be shown the reaction artifacts could be effectively minimized with the incorporation of XeF2 gas during the milling. This applications benefit analysis of a wide group of III-V semiconductors and chalcogenides that are vital in technologies such as solar panels.