Resist exposure with focused ion beams

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Focused ion beams can be used in nanoscale science and technology for direct nanofabrication (directly patterning materials), resist based processes[1] or for ion beam microscopy[2]. We have used focused beams of a variety of ions in order to exposure a variety of resists, including commonly used electron beam resists such as PMMA & HSQ with the smallest feature sizes < 15nm. The ion beams used were created using a Liquid Metal Alloy Ion Source (LMAIS) which is a versatile FIB source technology that is capable of delivering various ion species[3]. Light and heavy ions such as silicon and gold or lithium and bismuth are unified in a single source (AuGeSi or GaBiLi)[4]. Various ion species are emitted simultaneously from a single source and separated in a downstream Wien filter.

Exposing PMMA spin coated onto Si and GaAs substrates we see no observable proximity effect. This could make ion beam lithography with PMMA an attractive alternative to electron beam lithography for certain high-resolution applications. We discuss the results of PMMA exposure with Au, Si, Bi and Li ion beams. Figure 1 shows the results of exposing 950k molecular weight PMMA with 2% solids in anisole processed using conventional parameters for spin, bake, and development using MIBK:IPA. The resist was exposed using 35kV Li+ ions and a dose ~ 10 μC/cm^2. TRIM simulations have shown penetration depths in PMMA of > 500nm with 35kV Li^+ ions. In this talk we will survey the current state-of-the-art relating to ion beam exposure of resists and point towards potential future trends for applications and research activities.

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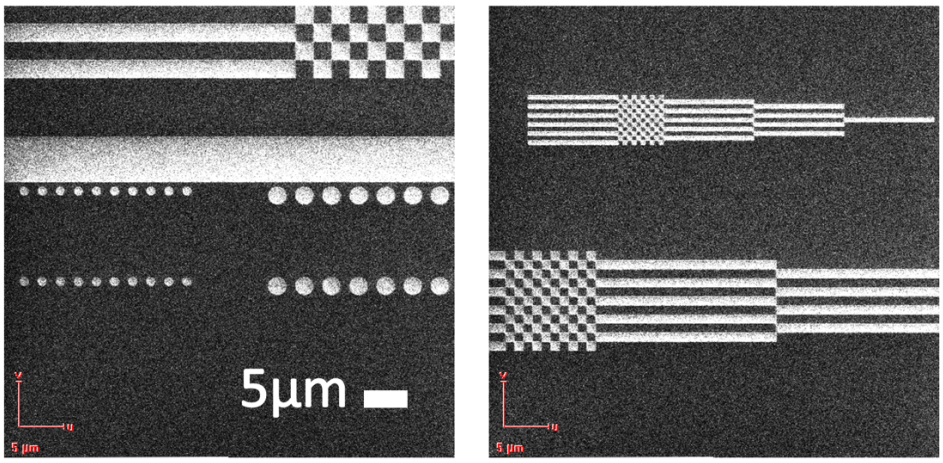

Figure 1: Post development ion beam microscope image of 60nm thick PMMA, 950k molecular weight, 2% solids in anisole on a silicon substrate. The resist was exposed using 35kV Li^+ ions.