50 nm lines patterned into silicon using water developable chitosan bioresist and electron beam lithography

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Electron beam (EB) lithography enables reaching very high resolution[1]. However, current chemicals used in EB lithography (resists, solvents and developers) not only generate safety and waste management issues but are also oil-based chemicals. With the issue of peak oil and with the regulations as REACH in Europe and Polluting Act in USA, finding a safer and synthetic free chemicals process is a key issue for eco-friendly EB lithography.

In the recent years, researches have been undertaken to replace the current synthetic resists as polymethyl methacrylate (PMMA) by water soluble, water developable and biosourced resists. For instance, Takei *et al*[2,3] used natural polysaccharides (dextrin and glucose from plants). But these polymers are chemically modified generally to enhance electrosensitivity. In addition, their low etching resistance requires a three layers process instead of the classical two layers.

In this work, chitosan (figure 1), a natural and abundant polymer soluble in aqueous solutions[4], was assessed as a positive and water developable resist for a two-layer EB lithography and transfer process. 50 nm lines patterns were successfully obtained in a chitosan film by EB lithography at doses between 140 $\mu C.cm^{-2}$ and 200 $\mu C.cm^{-2}$. The resulting features were, then, transferred into a silica layer by CHF_3 plasma reactive ion etching (figure 2). Finally, they were transferred into the silicon substrate with respect to the size and without line edge roughness.

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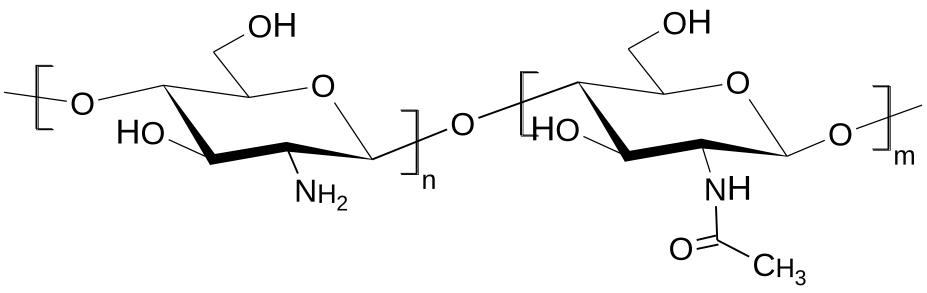

Figure 1: Structure of chitosan, the second most abundant biopolymer on Earth.

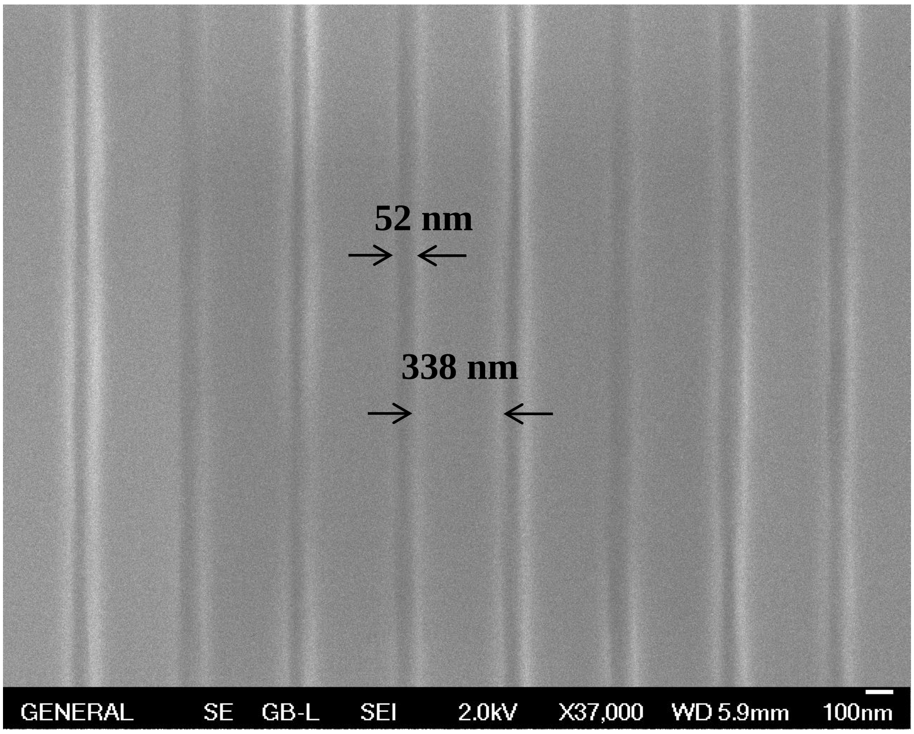

Figure 2 : SEM image of 50 nm lines patterns with a space between each line of 300 nm obtained in a film of chitosan after EB lithography, development in water and transfer into a silica layer by reactive ion etching.