Electron Beam Lithography (EBL) is a maskless lithography technique by which complex features are produced on a substrate with very high resolution. The operational principle of EBL is similar to that of photolithography with the exception that EBL is a direct-write process where patterns are directly engineered onto the substrate without the need of a mask. The substrate is coated with a thin layer of resist (e.g., polymethylmethacrylate) by spin coating, pre-baked, subjected to pattern writing in an electron beam lithography system (e-beam system), followed by resist development and pattern transfer. A schematic of a generic EBL process and SEM images of some of the structures thus produced are shown below. The major advantage of EBL is that it is not diffraction-limited like photolithography, and features with resolutions of up to 20 nm can be easily produced; indeed, sub-10 nm features can also be produced by EBL. However, the resolution of EBL is limited by the scattering of electrons in the resist. Furthermore, the throughput of EBL is very low as the processing time is directly proportional to the pattern area for a certain dose given by the equation $T \times I = D \times A$, where $T$ is the exposure time, $I$ is the beam current, $D$ is the dose in Coulombs/cm$^2$, and $A$ is the exposed area. In other words, it would take approximately 12 days to pattern a 1 cm$^2$ area with a 1 nA beam current and 1 mC/cm$^2$ dose. Of the many applications of EBL known to date, the most common are micromachining, fabrication of photomasks for photolithography, and fabrication of master patterns for soft lithography.
(Top) Schematic of an EBL process showing the formation of a metal structure on a substrate via electron beam patterning of a positive tone e-beam resist. (Bottom) SEM images of silicon nanodot arrays with varying pitch obtained by regulating the e-beam dose: (a) 40 nm, (b) 30 nm, (c) 25 nm, (d) 20 nm, (e) 15 nm, and (f) density of nanodots as a function e-beam dot dose (all scale bars correspond to 100 nm). These 60 nm deep silicon nanodot arrays were prepared by reactive ion etching ($\text{SF}_6 + \text{O}_2$) of a 20 nm thick negative tone e-beam resist, hydrogen silsesquioxane (HSQ), patterned by a 100 kV e-beam system. [Reference]