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How long can a monolayer thick silicon nitride island sustain oxygen exposure ?

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We have investigated the oxidation of Si(111) surface covered with a monolayer thick silicon nitride islands using scanning tunneling microscope (STM). Silicon nitride islands were formed by exposure of low energy nitrogen ions to Si(111)-7x7 surface at room temperature and a subsequent annealing at 980 °C. Controlling the amount of nitrogen ion dose, we could form silicon nitride islands with a diameter of 6 to 15 nm. In STM images, silicon nitride islands appeared as both bright and dark features surrounded by protruding walls. On this surface, oxygen gas was dosed at the surface temperatures ranging from 700 to 800 °C and oxygen pressures between 1×10^{-7} and 1×10^{-6} torr, where etching of silicon surface was dominant over oxide formation. Silicon pillars, covered with monolayer thick silicon nitride layer, as high as 2-3 nm appeared after reaction with O_2 gas as a result of selective etching of silicon surface area. Interestingly, the protruding walls surrounding the silicon nitride islands also remained unreacted. The I/V measurements on nitride area showed a passivated characteristics even after etching of up to 10 layers of Si indicating the rigidity of silicon nitride layer upon O_2 exposure. In this paper, we will discuss the formation of silicon nano-pillars and underlying etching mechanism of silicon nitride covered Si(111) surface.