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**Etch induced losses in high Q-value superconducting resonators**  
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80305 — We have investigated how the microwave loss in coplanar wave-guide titanium nitride resonators fabricated on Si wafers is affected by the choice of etch method used to pattern the resonators. Three different etches has been investigated, one fluorine based reactive etch, one chlorine based reactive ion etch, and one argon ion mill. At high microwave probe powers, the two different reactive etches show low internal loss whereas the milled samples show dramatically higher loss. At single photon powers we observe that the fluorine etch resonators exhibit substantially lower loss than the chlorine etched resonators. In the single photon limit we observe loss tangents of  $1 \cdot 10^{-6}$  for the fluorine etched,  $4 \cdot 10^{-6}$  to  $5.5 \cdot 10^{-6}$  for the chlorine etch and  $1.4 \cdot 10^{-4}$  for the argon ion mill. We compare these results to numerically calculated filling factors and find that the chlorine etch Si surface has a higher loss tangent than the fluorine etched surface. We also find that re-deposition of Silicon onto the titanium nitride surfaces is the probable cause of the high loss observed for argon ion milled resonators.

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