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***In situ* study of emerging metallicity on ion-milled $SrTiO_3$** NAMRATA BANSAL, HEIKO GROSS, YONG SEUNG KIM, CARLOS CHAPARRO, SEONGSHIK OH[1], Rutgers University — Here we show how metallic states emerge on the surface of $SrTiO_3$ (STO) single crystals through Ar-ion-milling process. It is well known that ion-milling creates oxygen vacancies on STO, creating a metallic surface state. So far, however, detailed studies of how ion-milling process induces metallic states on STO are lacking. In order to answer this question, we performed systematic *in situ* conductance measurements on STO crystals in various conditions inside a high vacuum chamber. Ion-milling temperature was a crucial factor in determining the properties of the conducting state. At cryogenic temperatures, thermal diffusion is suppressed and ion-milling creates conducting states only at the very top surface. However, near or above room temperature, the conducting state diffuses deeply into the bulk. Higher temperature also fostered vacancy clustering. Because clustered vacancies trap electron carriers, the clustering causes electrical conductivity to drop. We observed up to four times reduction in conductivity due to cluster formation.

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