Interface Control and Characterization of SrTiO3/Si(001)

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Abstract

Epitaxially grown strontium titanate ($SrTiO_3$, STO) is an essential interlayer that enables the integration of functional perovskite oxides on large scale substrates of Si(001) thus enabling a wide range of applications in electronics and photonics. As a buffer layer, the crystallinity of STO directly impacts the properties of the oxides on top. In this study, we varied the molecular oxygen exposure amount prior to the STO growth to control the SrO/Si interface conditions. We show how the oxygen not only impacts the interface but also the crystallinity and more interestingly the stoichiometry in the STO films. With overexposure of molecular oxygen, the chemical binding states show the formation of SiO_x, resulting in amorphous growth of the STO. In addition, the stoichiometry of Sr/(Sr+Ti) ratio changed dramatically as the exposure amount increased. The change of crystal quality and stoichiometry is also reflected in the optical constants, with a reduction n&k observed. The change of stoichiometry is linked to the formation energy of different oxides, confirming the importance of controlling the oxygen amount in direct STO epitaxy on Si substrates. Finally, additional annealing shows an improvement by reducing the absorption of the STO films, which is crucial for photonic applications.

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