Single Crystalline $BaTiO_3$ Grown by Pulsed-laser deposition (PLD) on $SrTiO_3$ / Si Pseudo-substrate

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ABSTRACT

Future applications such as high-speed chip-to-chip optical interconnects, compact high-resolution beam steering and video-rate RGB hologram generation require the integration of fast and efficient optical modulators on top of silicon CMOS devices. For these applications the integration of high quality electro-optical materials on silicon wafers is hence required. Among the possible material options, barium titanate ($BaTiO_3$) is one promising candidate due to its large intrinsic Pockels coefficients. However, the reported Pockels coefficients in literature strongly depend on the obtained crystal lattice stress and axis orientation. In this work, we demonstrate a single-crystalline PLD-grown $BaTiO_3$ (BTO) on top of a MBE-$SrTiO_3$ /Si(001) pseudo-substrate. We investigated the orientation of the polarization axis of single-crystalline BTO under different growth conditions by X-ray diffraction. Larger Pockels coefficients are obtained for a-oriented BTO with its elongated axis lying parallel to sample surface. The control of growth conditions enables us to change polarization by selecting between c- and a-growth axis orientation with tetragonality control of single crystalline BTO films ranging from 0.98 to 1.02. For the a-BTO, the out-of-plane ω-scan shows good crystalline quality with FWHM of 0.37˚. Using STEM and NBD, we relate the crystalline orientation switch to strain relaxation inside BTO films.