Aluminum-induced crystallization of Si (111) on highly mismatched crystalline substrates

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Using the aluminum-induced crystallization (AIC) process, thin (t < 50nm) Si and Ge (111) films with >95% surface orientation have been fabricated on amorphous substrates in recent years. However, since crystallization is proposed to occur at the substrate/Al interface for these films, crystallization on crystalline substrates should allow the crystal lattice of the underlying substrate to influence preferential orientation in the silicon film. In this report we investigated AIC on crystalline substrates.

AIC-Si films were fabricated by depositing ~30nm of Al onto single crystalline strontium titanate (100), (0001) sapphire, and (0001) GaN substrates. Following a brief air exposure, ~30nm of amorphous silicon was deposited. Subsequent annealing at 450°C formed crystalline silicon thin films.

As can be seen in Figure 1, Si (111) is formed preferentially on all crystalline substrates regardless of lattice mismatch (18% for GaN (0001) vs Si (111), 27% for (0001) sapphire), or close lattice matching to another surface orientation (3.4% mismatch for Si (001) and STO (001)). From x-ray diffraction, no Si (001) peak can be observed, confirming the uniform surface orientation of the AIC-Si films. These results are confirmed by EBSD and agree with previous observations of AIC on amorphous and polycrystalline thin films. Based on these results, it may be possible to integrate crystalline silicon with previously incompatible substrates. In contrast, AIC-Si crystallization on Si (001) substrates still produces only Si (001) films. Therefore, it may be possible that different crystallization mechanisms occur for AIC of silicon on silicon vs. non-silicon substrates.

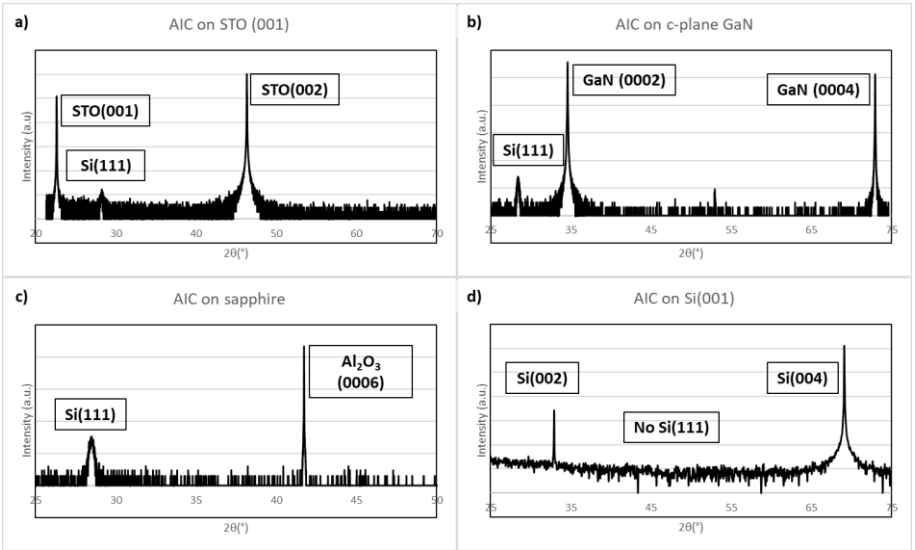

Figure 1: XRD of AIC-Si films on a) STO (001), b) GaN (0002), c) Sapphire (0002), and d) Si(001) showing preferential Si(111) formation on non-Si substrates.