Very Low Temperature Growth of C-axis Oriented ZnO Thin films on Si Substrates.

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In recent years, wide band-gap semiconductor materials have attracted a great deal of attention for use in blue light-emitting and short-wavelength diodes. Additionally, due to its high conductance, chemical and thermal stability, and high piezoelectric coupling coefficient, ZnO is also used for piezoelectric devices, such as surface acoustic wave (SAW) devices [1] and bulk acoustic devices [2]. Also, High quality ZnO films grown on Si substrate pave the way from integration of devices with Si IC technology. In this presentation, we report that the ZnO layers were grown on Si substrates using metal-organic chemical vapor depostion (MOCVD) in the temperature range of 100-200C. Fig. 1 shows XRD patterns of ZnO thin films on Si(100) grown at (a) 100, (b) 150, and (c) 200℃. The θ-2θ scan data of ZnO films exhibits a strong 2θ peaks at 34.53° in the sample grown at 200℃, corresponding to the (002) peaks of ZnO. The observation of the strong (002) peak indicates that the film is grown with a c-axis orientation. On the other hand, at lower temperatures in the range of 100-150 ℃, the relative intensity of the (002) diffraction peak compared to the neighboring (100) and (101) peaks is lower than the relative intensity at 200 ℃. We surmise that the degree of c-axis orientation in ZnO film decreases by decreasing the growth temperature. Fig. 2a and b show the SEM images of ZnO thin films grown on Si(100) substrate at 100℃ and 200℃, respectively. They show that the ZnO film structure grown at 200 ℃ consists of some columnar-structured grains, representing c-axis oriented grains. However, the ZnO film structure grown at 100 ℃ does not clearly show the columnar structured grains.

We thus have demonstrated the growth of ZnO thin films on Si(100) substrate at low temperature of 100-200 ℃, using the MOCVD reactor. The c-axis orientation based on XRD analysis improves with increasing substrate temperature. X-ray diffraction reveals that the ZnO films are highly c-axis-oriented and the line width of ZnO(002) peak is significantly small and the full width at half maximum (FWHM) of 0.44° was achieved at 200℃. We also reveal that the growth of ZnO thin film on silicon substrate is achievable even at a low temperature of 100 ℃. Growth temperature of high quality ZnO films are significantly lowered using MOCVD, showing light on the potential application of ZnO film on electronic and optoelectronic devices.

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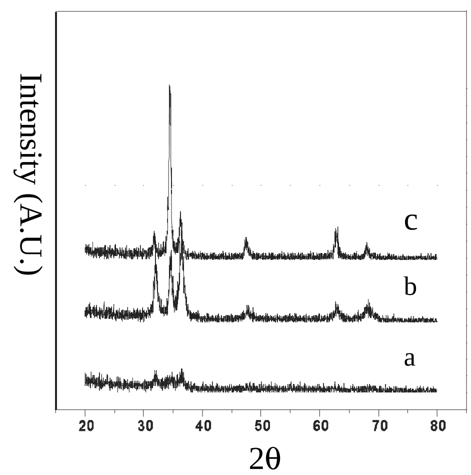
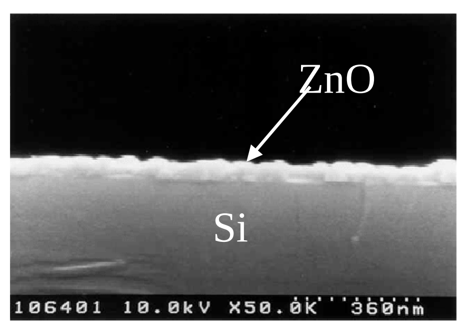
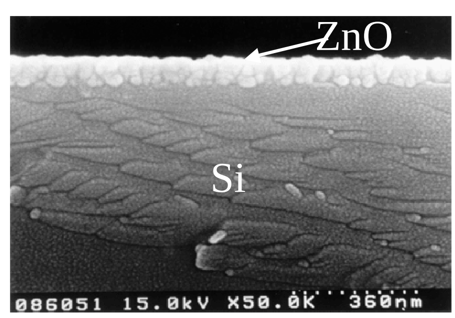


Fig. 1



(a) 100℃



(b) 200℃

Fig. 2