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Analysis of Root Mean Square Roughness of Microcrystalline Silicon Thin Films Using Scanning Probe Image Processor software

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Abstract

We have done an analysis of the root mean square roughness (RMS) of microcrystalline silicon (µc-Si) thin films grown by aluminium induced crystallization (AIC) using Scanning Probe Image Processor software (SPIP). Surface roughness profiles from *Dektak 3030* step profiler and topography images from atomic force microscope were loaded into SPIP software. These profiles and images were from films grown at different annealing temperatures. Microcrystalline silicon by aluminium induced crystallization (AIC) is usually used as a seed layer for further epitaxial thickening using methods such as hot wire chemical vapour deposition and ion assisted deposition. The seed layer surface should therefore be smooth for its material properties to be transferred to the epitaxial layer. Films were found to have the largest root mean square roughness at about 470 °C in both measurements. A temperature range of 340-420 °C has been suggested for the growth of AIC seed layer that can give intermediate root mean square roughness and significant crystallization for use in solar cell applications.

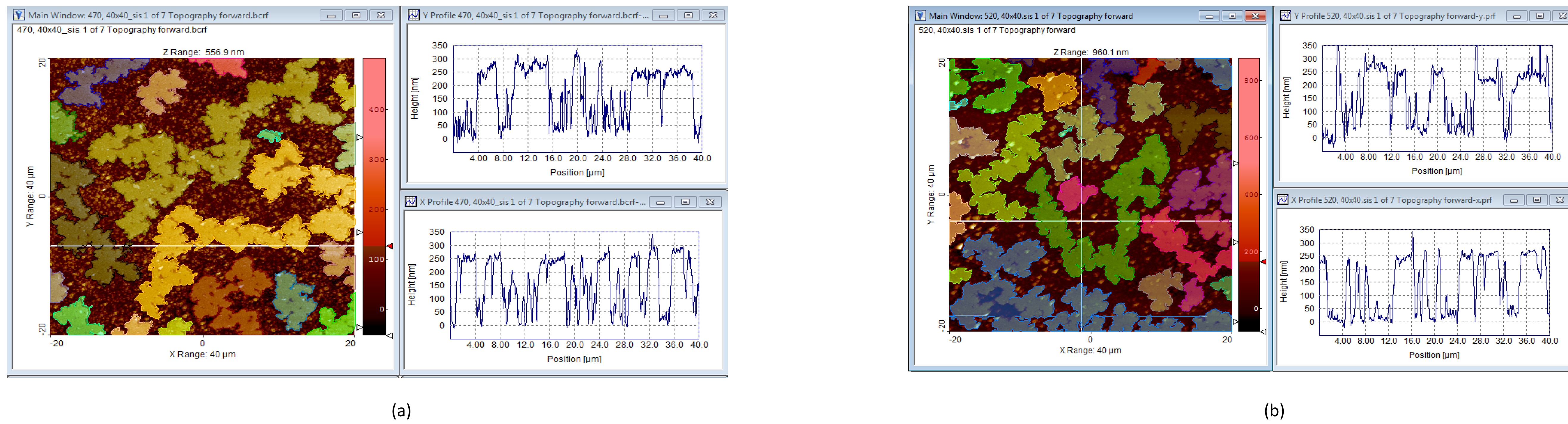

Figure 1: Particles as detected by SPIP and the corresponding X and Y profiles for films annealed at 470°C and at 520°C

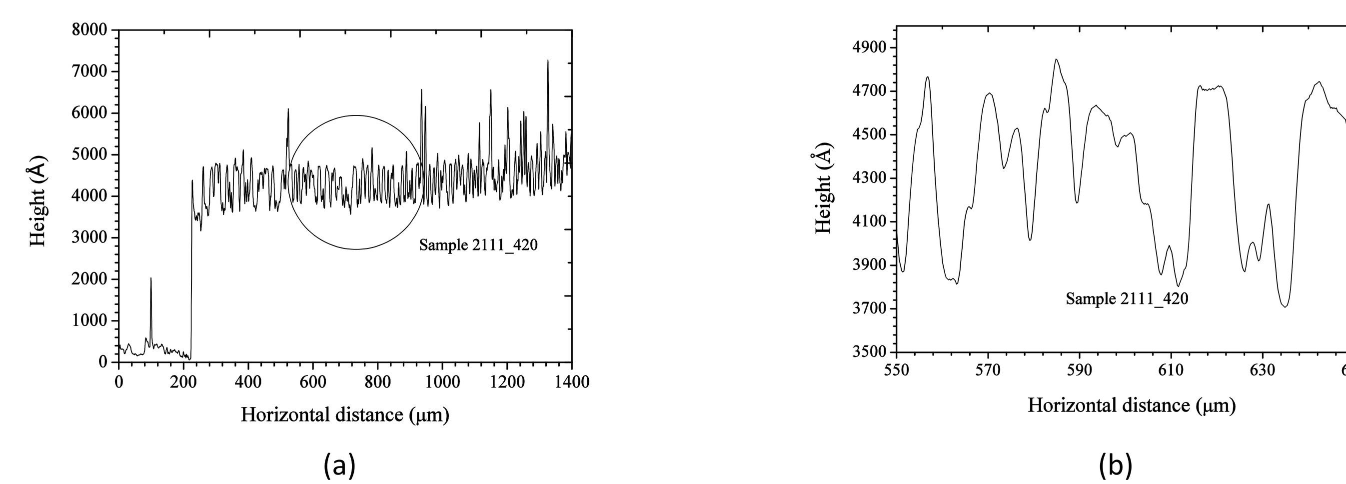

Figure 2: Step profiler surface roughness raw profile for films annealed at 420°C (a) and the corresponding extracted profile (b)

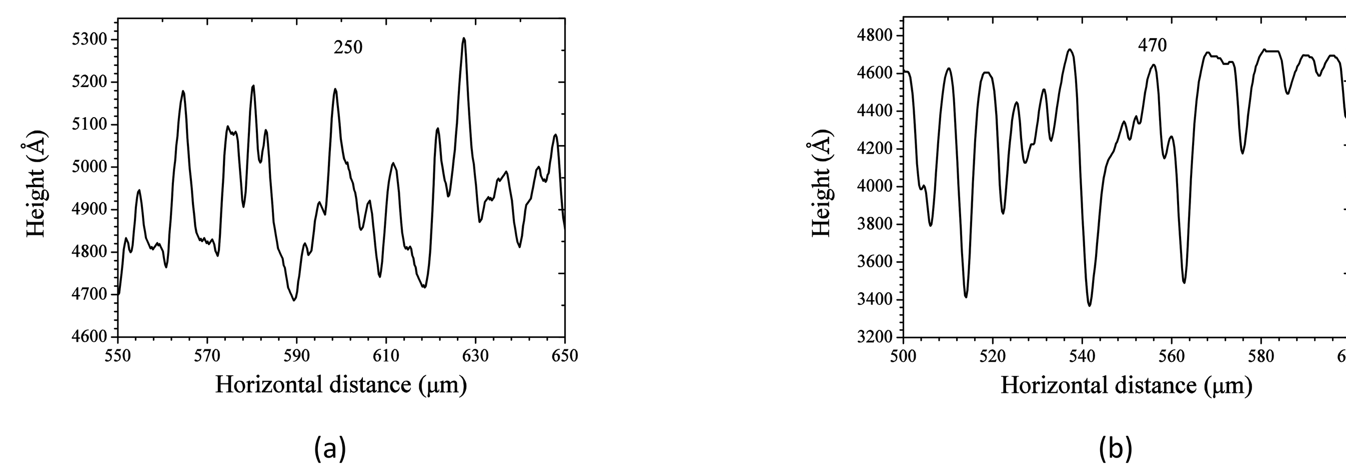

Figure 3: Extracted step profiler low root mean square surface roughness profile for films annealed at 250°C (a) and the largest extracted root mean square surface roughness profile for films annealed at 520°C (b)

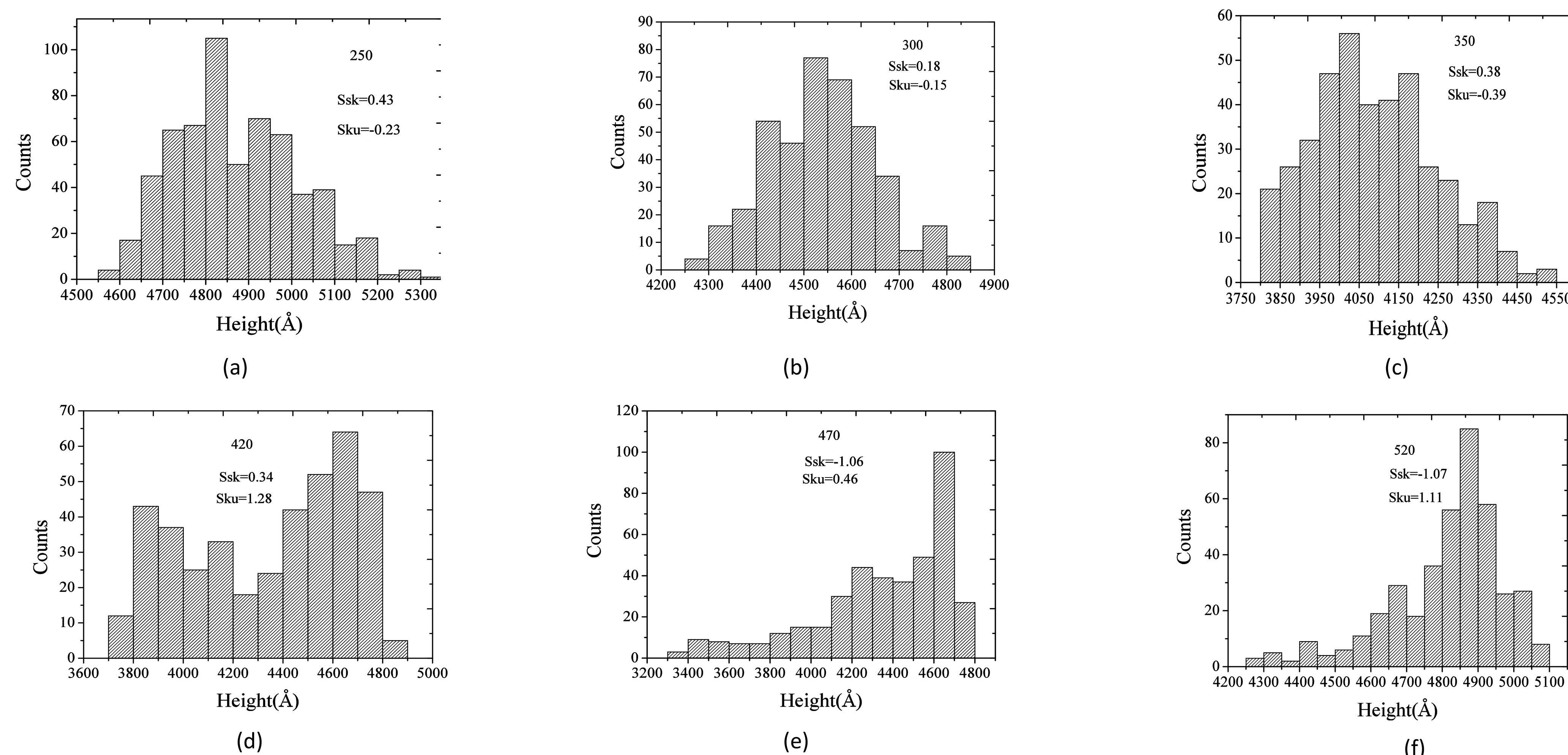

Figure 4: Root mean square surface roughness histogram distributions of the extracted profiles at temperatures between 250 °C and 520 °C

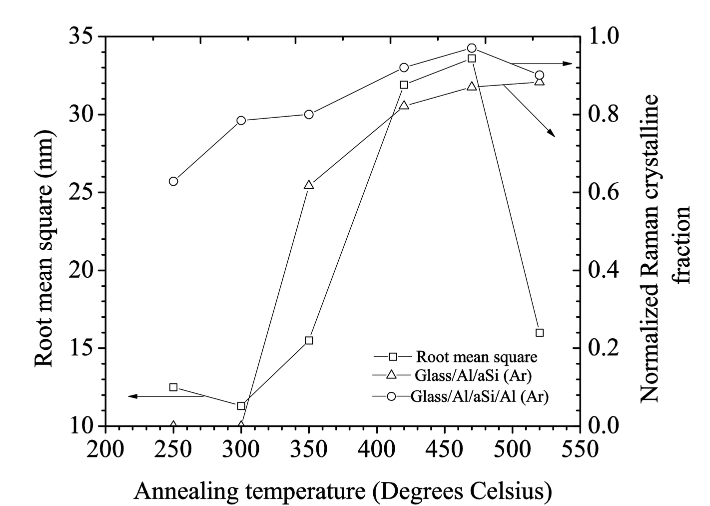

Figure 5: Variation of root mean square surface roughness and Raman crystalline volume fractions of µ c-Si from annealed Glass/Al/aSi and Glass/Al/aSi/Al layers on glass substrates

Conclusion

Films annealed below 420°C had gaussian histogram distribution of the heights implying relatively smooth films. Films annealed over 420 °C had asymmetrical distributions towards large heights , an indication of increasing roughness. Atomic force microscope images root mean square roughness (s_q) at 470 °C and at 520 °C had average values of 128 nm and 117 nm respectively for values found by averaging (s_q) due to mean plane correction and first order plane correction. A temperature range of 340-420 °C has been suggested for the growth of AIC layers, the range in which appreciable crystallization occurs.

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References

Aberle A. G. , Straub A., Widenborg P. I., Sproul A. B., Huang Y., Campbell P. Polycrystalline silicon thin-film solar cells on glass by aluminium-induced crystallisation and subsequent ion-assisted deposition (ALICIA). *Prog. Photovolt: Res. Appl.* ***13**, (2005) pp 37–47*

Hongbo B.T.L., Ronald H.F., Jatindra K.R.,Ruud E.I.S. Structural defects caused by a rough substrate and their influence on the performance of hydrogenated nano-crystalline silicon n–i–p solar cells. *Solar Energy Materials & Solar Cells* ***93**, (2009) 338–349.*

Jorgensen., J.F L. Madsen, K. Carneiro and K. Conradsen. Hysteresis correction of STM images, *JVST B*, ***12**(3), (1994a) 1702-1704*

Widenborg P. I. Straub A., Aberle Armin G.. Epitaxial thickening of AIC poly-Si seed layers on glass by solid phase epitaxy. *Journal of Crystal Growth* ***276**, (2005) 19–28*