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Influence of annealing conditions on the properties of Cu(In,Ga)Se_2 thin films fabricated by electrodeposition

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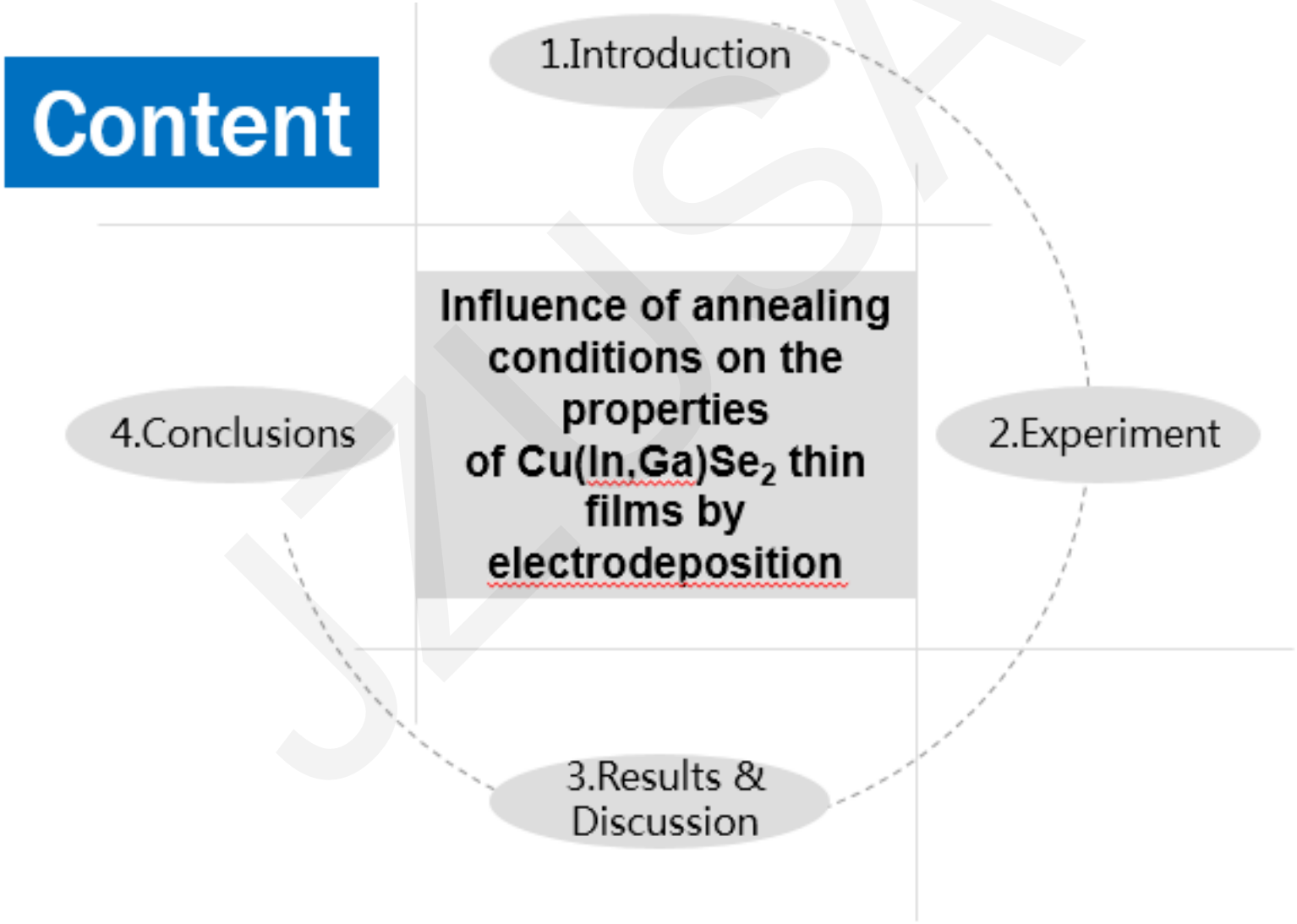
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- **Introduction**

  CIGS precursor films were fabricated by electrodeposition and then the effects of selenization temperatures and heating rates on the properties of the films were investigated. X-ray diffraction (XRD) spectra, scanning electron microscopy (SEM) and Raman scattering spectroscopy were used to investigate the components and structure of the films under different conditions.

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- **Experimental Procedure**



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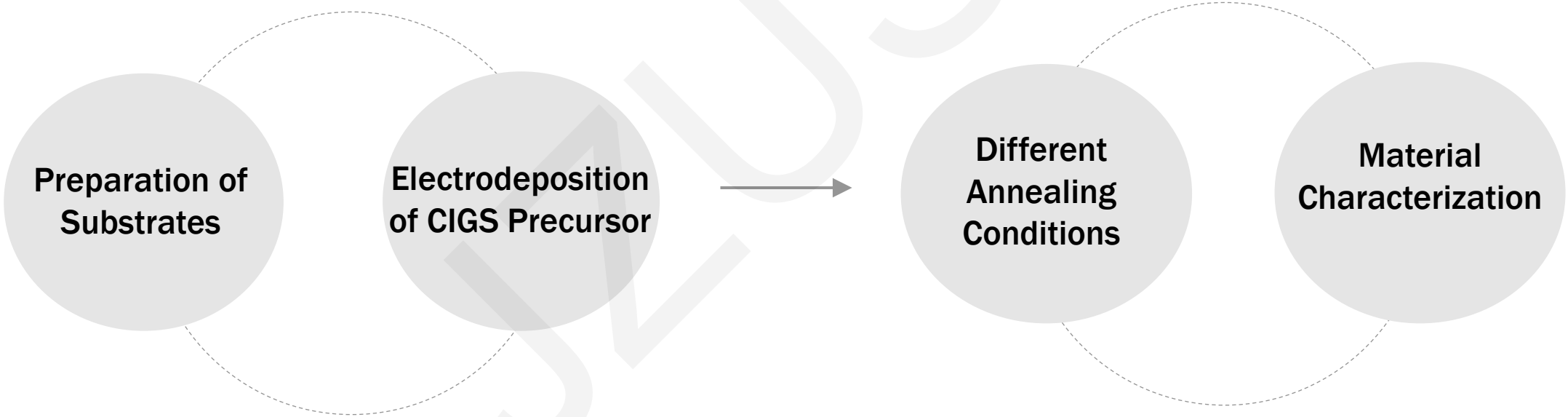
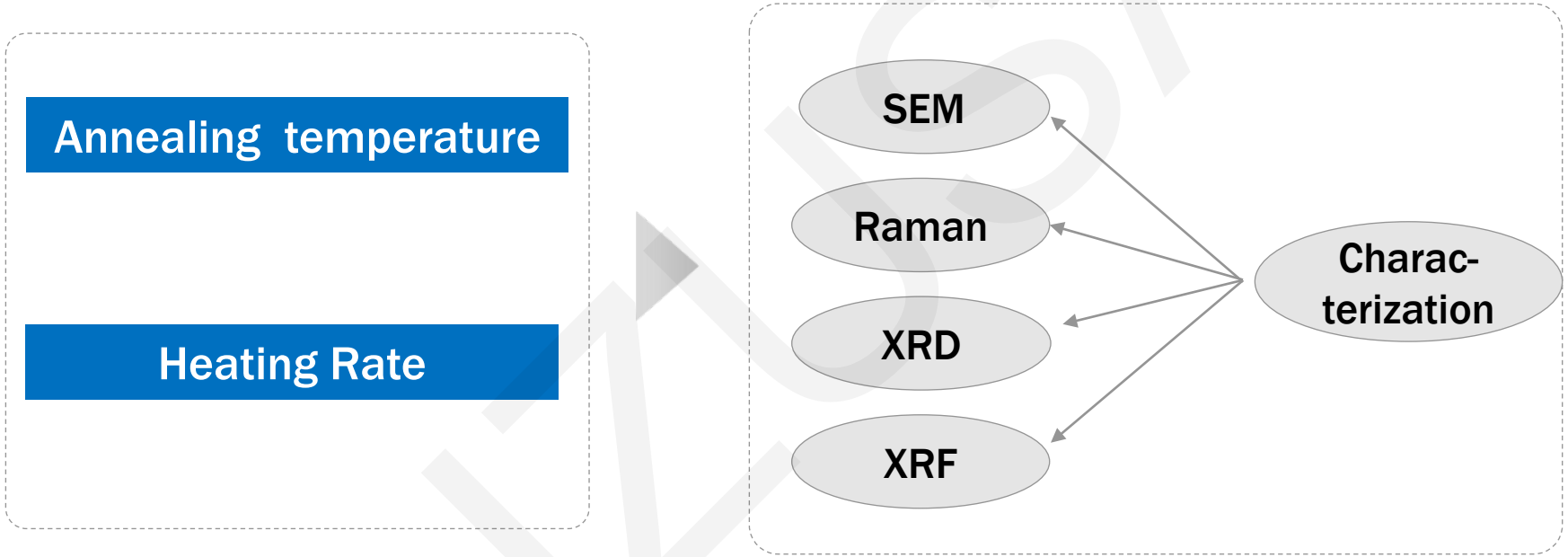


- **Method**



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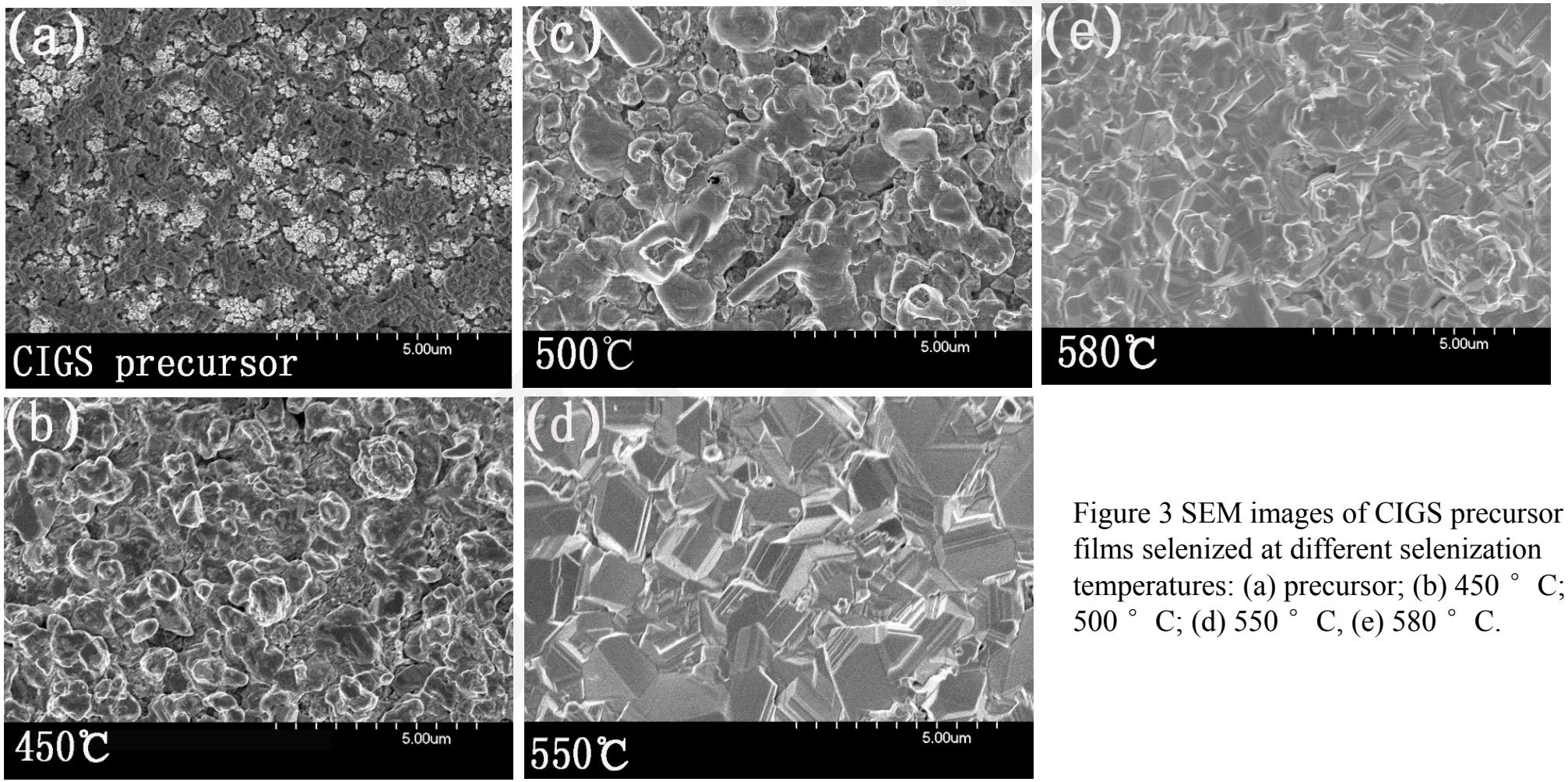

Figure 3 SEM images of CIGS precursor and films selenized at different selenization temperatures: (a) precursor; (b) 450 ° C; (c) 500 ° C; (d) 550 ° C, (e) 580 ° C.

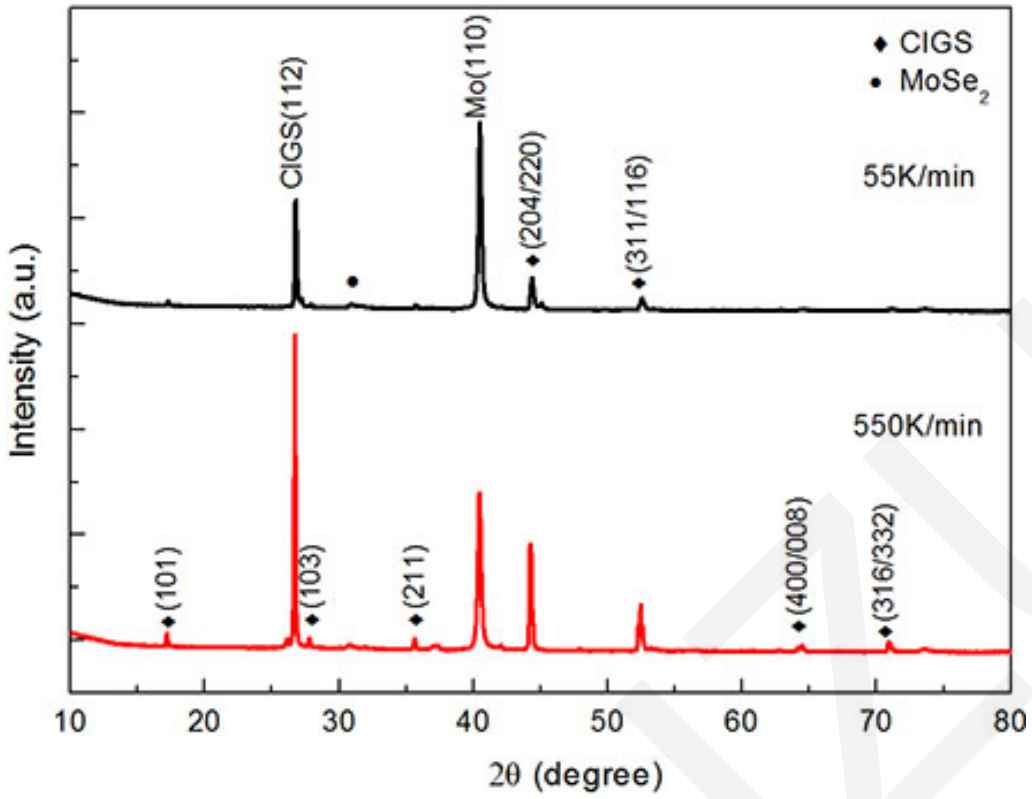

Figure 4 XRD patterns of of CIGS films selenized at 550℃ for 1h with different heating rates

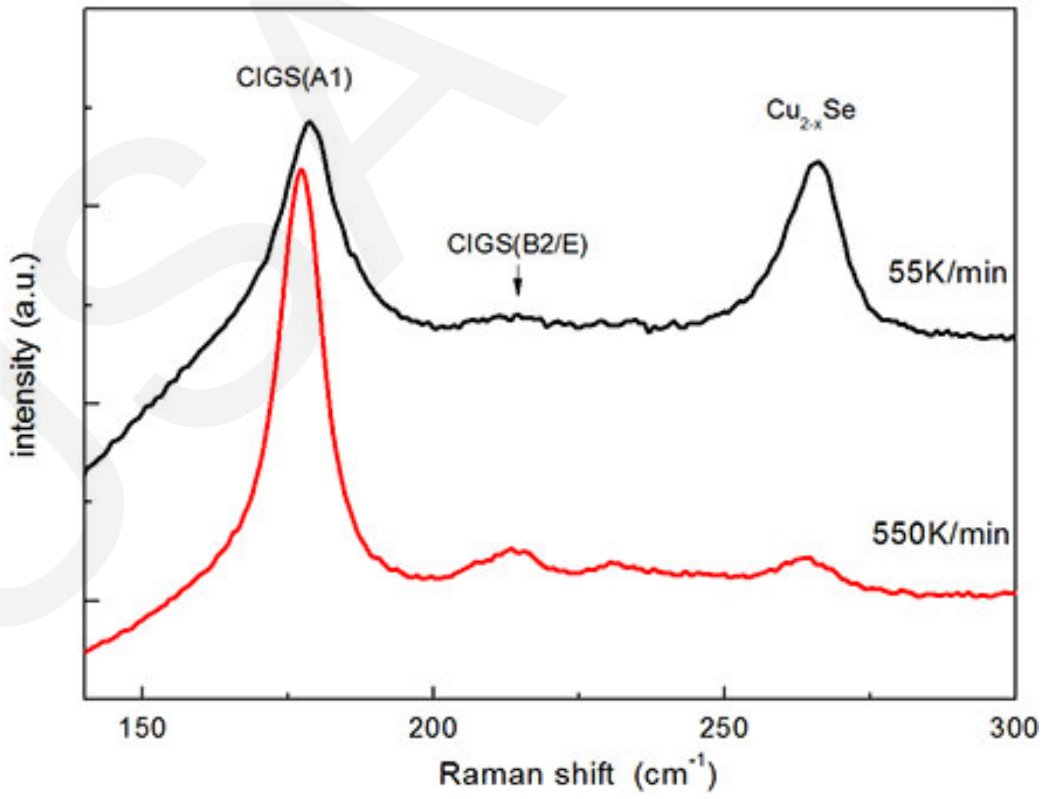

Figure 5 Raman spectra of CIGS films selenized at 550 ° C for 1h with different heating rates

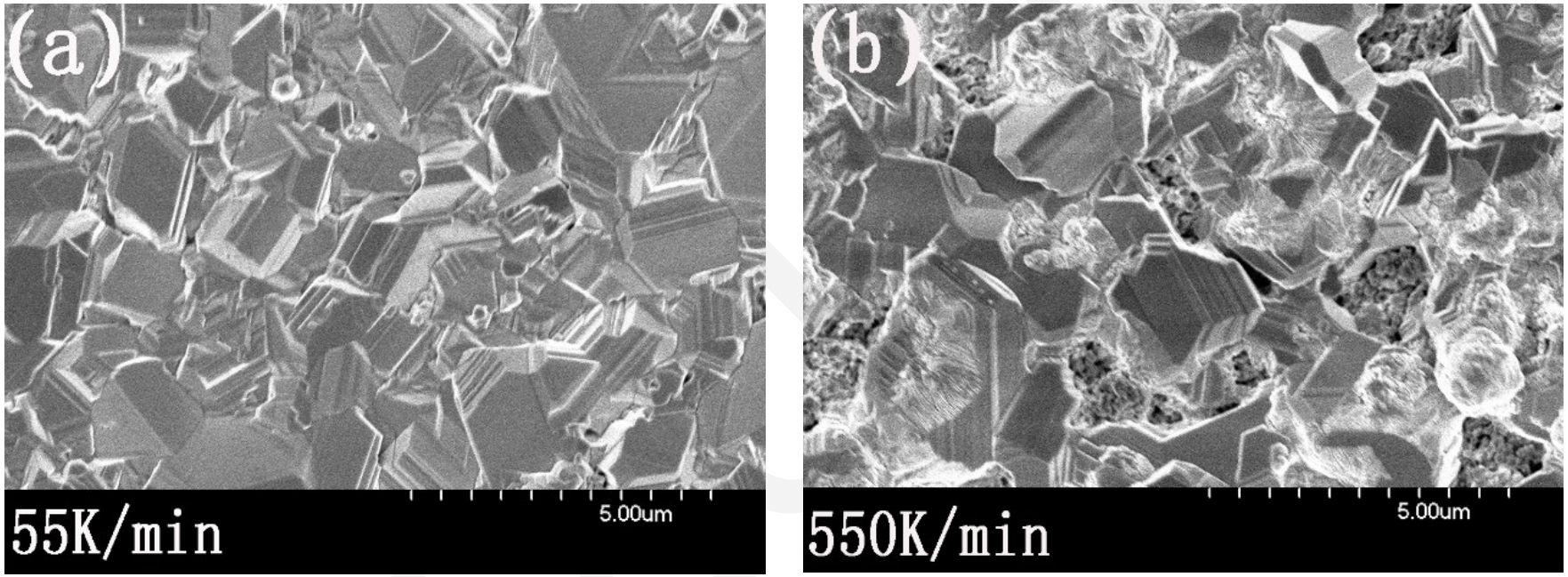

Figure 6 SEM images of CIGS films selenized at different 550° C for 1h with different heating rates (a) 55K/min, (b) 550K/min

Conclusion

- The ratios of Cu/(In+Ga) and Ga/(In+Ga) are likely to increase with elevated selenization temperature.
- As annealing temperature ranges from 450 ° C to 550 ° C, the improvement of film crystallinity is due to the increase of Cu_2Se phase, but the amount of binary Cu-Se phase decreases. After annealing at 580 ° C, minimum amount of $Cu_{2-x}Se$ compounds were obtained and the degree of CIGS film crystallinity was higher than other samples.
- For the samples treated by fast heating, the ratio of Cu/(In+Ga) was slightly lower than samples treated by slow heating. The ratio of Ga/(In+Ga) remained unchanged.
- Crystallinity of the films improved noticeably with the increase of heating rate as well as the grain size became larger.

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