IPID4all Senior Research Exchange with Dr. Levent GÜTAY, University of Oldenburg
Feedback report

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Absorber CZTS Layer for Photovoltaic Applications

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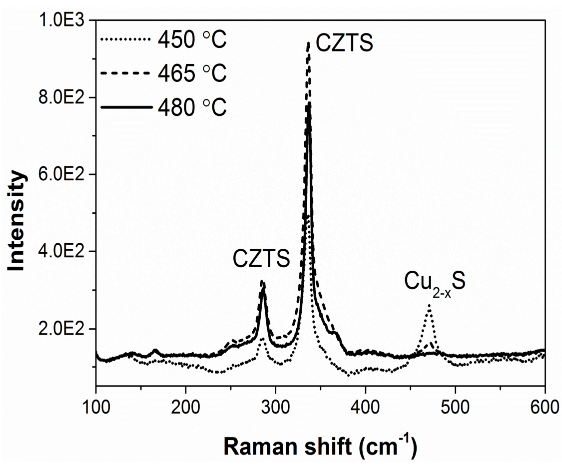
Activities / Contacts

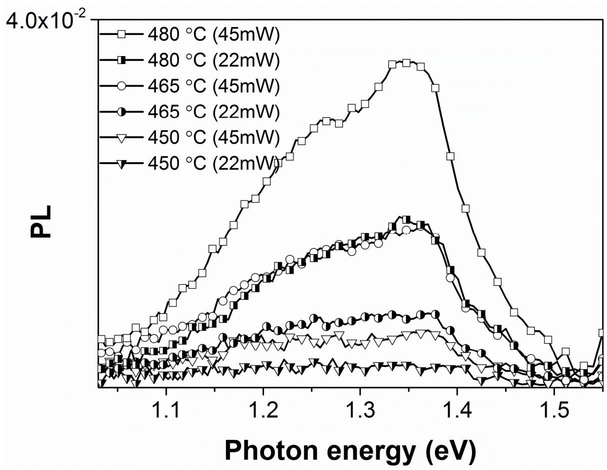
Laboratory for Chalcogenide Photovoltaic (LCP) group under the leadership of Dr. Levent GÜTAY and Prof. Jürgen PARISI has great experience on compound semiconductors for solar cell applications. Recently kesterite $Cu_2ZnSn(S,Se)_4$ absorber layer is attract attention for solar cell application and many research groups working on the fundamental problems of CZTS to get high efficient device.

During this visit, I have visited the all laboratories and met with the group members and discuss the main problem about the deposition of CZTS with spin coating, and also learn about different growth techniques that are used in University of Oldenburg such as doctor blade, spray pyrolysis and sputtering. In addition to the experimental research I have learned about optical simulation (OptiSim) and device simulation (SCAPS) that are used in the host university. Both programs are available online as free of charge and can be downloaded in any computer.

Spin coated CZTS samples were prepared and annealed at different temperatures in home university. These samples were taken for characterization employing facilities of host university. Raman spectroscopy has performed on these samples using Horiba Labram Aramis with 532nm excitation laser (Figure 1a). Undesired secondary phase $Cu_{2-x}S$ peak was observed at 457 and eliminated by increasing the annealing temperatures. PL measurements were performed at room temperature with 660nm excitation laser (Figure 1b) with different powers.



(a)



(b)

Figure 1. (a) Raman measurement (b) Photoluminescence vs photon energy.

FEI- SEM was employed to obtain surface morphology and elemental composition. SEM images of as deposited and annealed at 500 °C are given in Figure 2. The annealing process improved the crystallisation. The images are taken at the same resolution.

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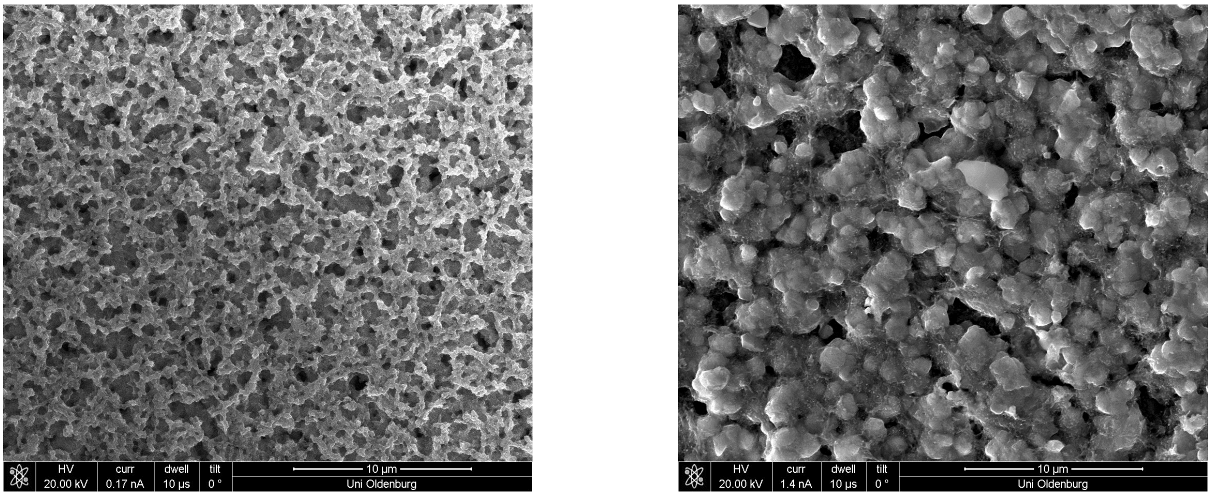

(a) (b)

Figure 2. SEM images of as deposited (a) and annealed at 500 °C.

The optical transmission and reflection of these samples have measured using Bentham with integrated sphere. This data have used to calculate the optical band gap. The transmissions versus wavelength for different annealing temperatures were plotted in Figure 3a. The main increase in transmittance was achieved by the formation of granulation with an increase in temperature to 480°C, and thus an increase in crystallization. Optical band-gap energies of the films were determined by extrapolating the linear region of the $(\alpha h\upsilon)^2$ vs $h\upsilon$ and by taking the intercept on the $h\upsilon$ axis as shown in Figure 3b. The optical energy gap reached the optimal value by increasing the annealing temperatures.

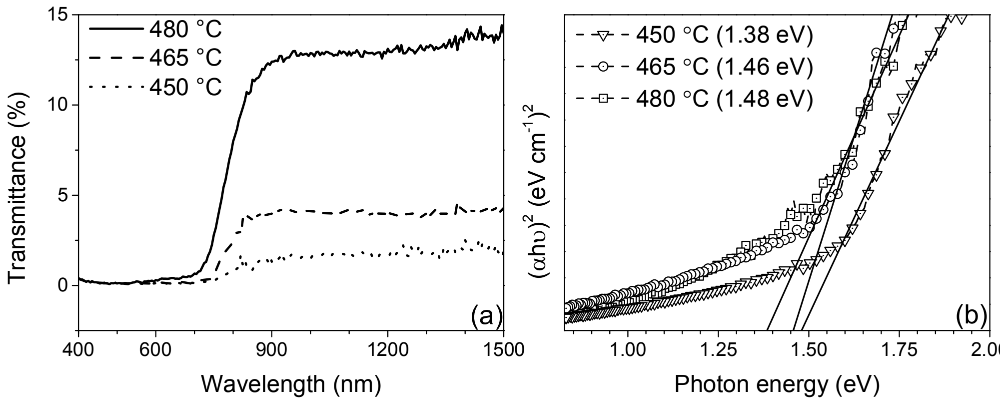

Figure 3. (a) Transmission versus wavelength (b) $(\alpha h\upsilon)^2$ vs photon energy for different annealing temperatures.

The all characterisation techniques give us information about the quality of the samples that were prepared at home university. By evaluation of these results and also discussion with the host university group, we will have opportunity to improve our growth process for better quality of CZTS. By improving the growth process we will get opportunity to fabricate solar cell using this absorber layer.

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Meeting with the researchers from the University of Oldenburg who has common research purpose with our group was a brilliant and fruitful experience for me. I graciously acknowledge the support from DAAD with funds from BMBF and the Laboratory for Chalcogenide Photovoltaics Group of University of Oldenburg for accepting me to take part in the exchange program.

Future collaboration / Outlook

During this visit I have presented seminar to the host research group and give information about our group capability and lab facility as well. In addition to this, we discuss the possibility for collaborative research proposal and submitting joint research project with the group leader. The International Bureau of the Federal Ministry of Education and Research of Germany (BMBF)/German Research Foundation (DFG) and Turkish Scientific Research Council (TUBITAK) has bilateral cooperation agreements for joint research project between German and Turkish researchers. We may take this opportunity to submit research proposal in the future.

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DAAD

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