Sulfurization of Cu-In particles in Aqueous Solution
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1. Background
Copper Indium Gallium Selenide (CIGS) solar cells are very advantageous solar cells. CIGS solar cells can achieve high efficiency, uses a small amount of material (thin film), and can be deposited on flexible substrates [1][2]. Co-evaporation as the main manufacturing process for high efficiency devices has some disadvantages such as being difficult to control, requiring high temperature and wasting materials [2][3].

Non-vacuum particulate based process is a possible simpler and cheaper alternative to co-evaporation where particles can be directly deposited on to a substrate by methods such as printing [3]. In our laboratory, copper indium (Cu-In) nanoparticles have been synthesized as precursor for printing solar cells. However, up to this point, selenization by using highly toxic H2Se gas at temperature higher than 500°C is necessary to obtain CuInSe2 phase.

In this experiment, we try to replace the toxic gas selenization process by a process in aqueous solution. Because selenium is highly toxic material, we focus on sulfurization first instead of selenization. The goal is to obtain copper indium sulfide (CuInS) phase.

2. Experimental
Synthesized Cu-In NPs was sulfurized by mixing in aqueous solution with sulfur ions. Sodium sulfide (Na2S) was used as sulfur ion source.

3. Result and Discussion
Sulfurization with 0.5 M Na2S solution at 50°C showed some phase change into possibly copper sulfide (Cu3S16). At 5 hours reaction time indium concentration in the particles was very low, possibly because it had formed indium sulfide (In2S3) which was subsequently dissolved in the solution. To prevent indium leaking out, Na2S solution saturated with In2S3 was used for sulfurization. Higher indium concentration was retained in the particles, however, no CIS phase has been observed.

Figure 1. Cu-In particles after being sulfurized with sodium sulfide saturated with indium sulfide for 5 hours at 50°C

4. Conclusion
Some phase change has been observed in the Cu-In being sulfurized, however, no CIS phase has been observed.

References

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