# Synthesis of Copper Zinc Tin Sulfide Nanoparticles

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**Introduction:**

Many solar cells are made with relatively rare (and therefore expensive) materials, and some, like lead and cadmium, are hazardous to the environment. Thus, efforts are being made to make solar cells from readily available, non-hazardous materials that retain or exceed the efficiency of those that are already being produced. One promising material is copper zinc tin sulfide (CZTS). However, the solar cells made from bulk CZTS are not sufficiently efficient to replace those currently on the market. Because of this, research in the use of CZTS nanoparticles for solar cells is in its early stages. When the size of a material approaches that of the magnitude of the electron wave function of that material (as with a nanoparticle), these particles can exhibit a phenomenon called quantum confinement: the band gap, or the energy of light that can be absorbed by the material to produce electricity, can be tuned by changing the size of the particle. Thus, efficient solar cells can be made using layers of nanoparticles of different sizes that will absorb a wide range of sunlight.

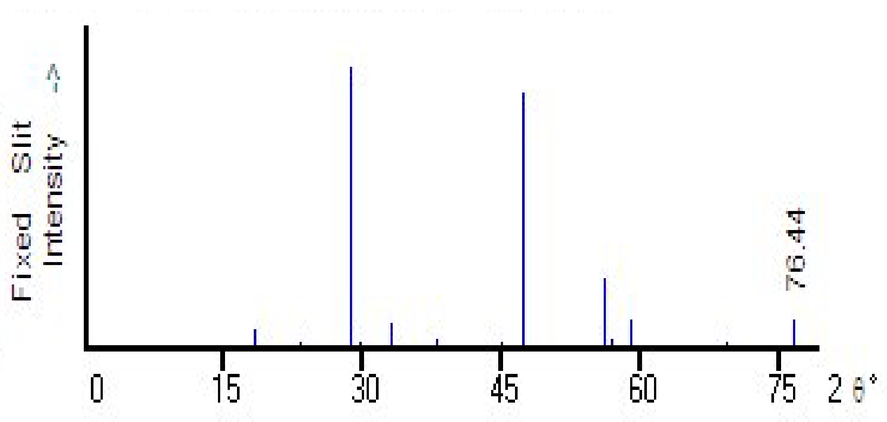
**Procedure:**

- Three metal precursors (copper, tin, and zinc)
- Organic solvent
- Two organic capping ligands
- Performed on Schlenk line to remove oxygen
- Synthesis done between 150°C and 200°C
- Compositions varied (usually Cu:Zn = 2:1)
- Resulting nanoparticles cleaned in centrifuge, finally dispersed in toluene

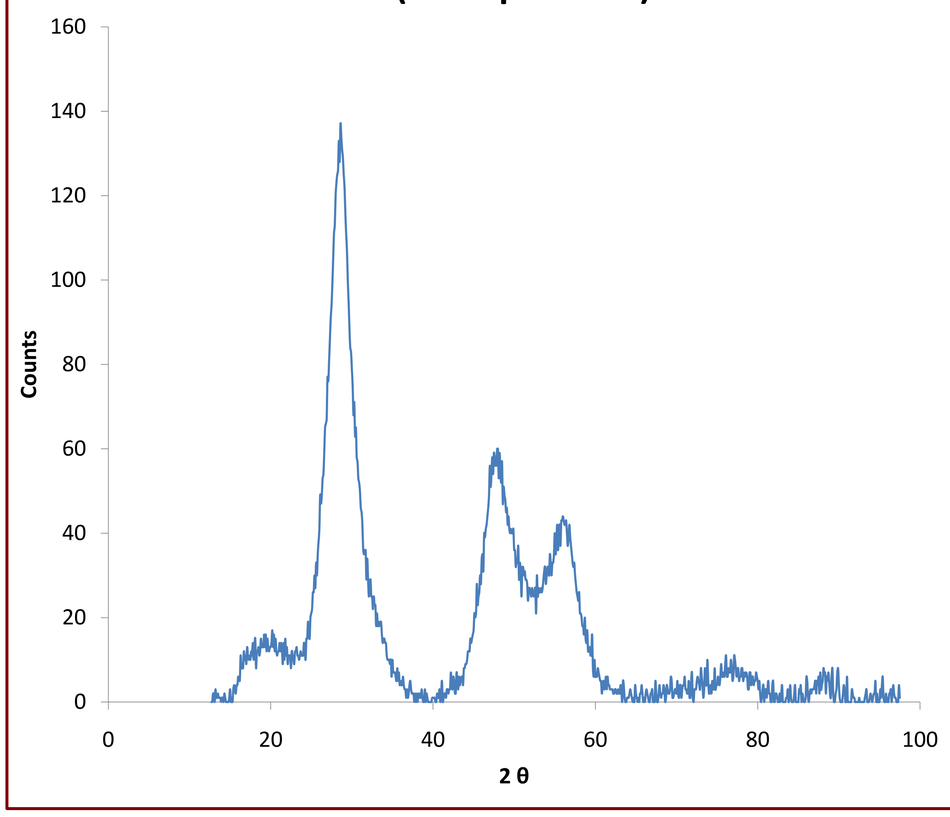
**Results:**

The composition of the nanoparticles was determined using x-ray diffraction (XRD). The data was compared to literature values to confirm the nanoparticles as CZTS. The size of the nanoparticles was then approximately determined using transfer electron microscopy (TEM). TEM images of nanoparticles of various Cu:Zn ratios showed that changes in composition do not greatly affect size. Finally, the absorbance of the particles was taken to determine whether changes in composition affect their interaction with light and, therefore, applicability for solar cells.

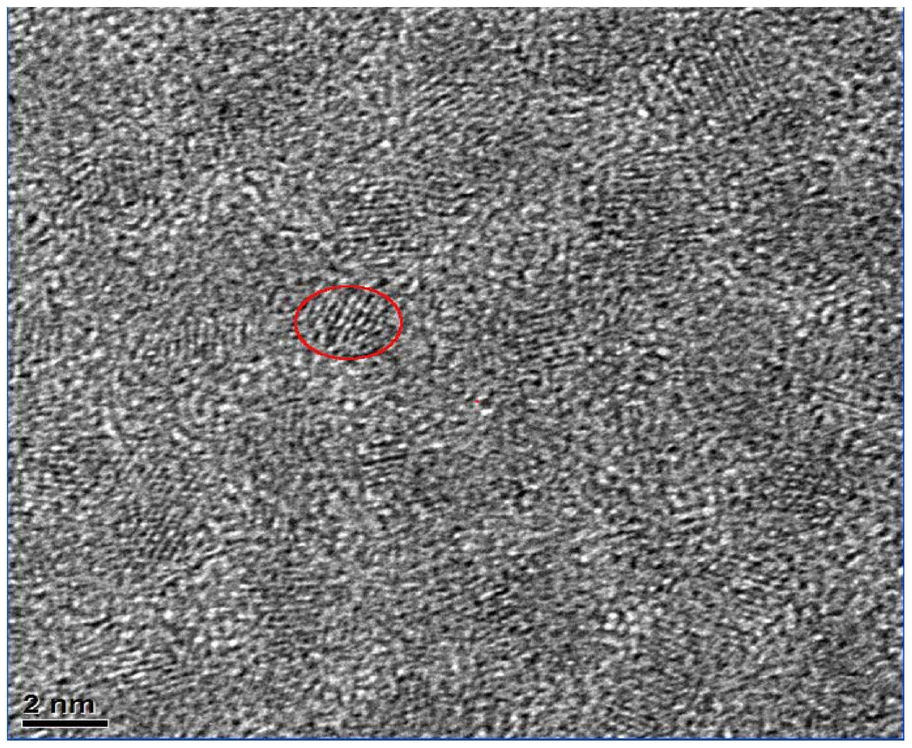
**XRD Data from Literature:**



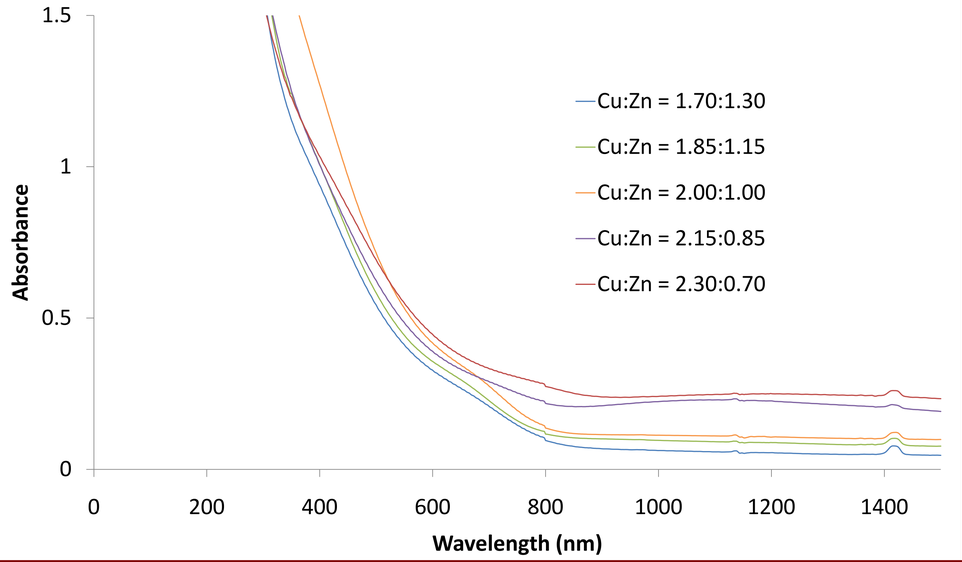

**Measured XRD Data (2 nm particles):**




**TEM Image:**




**CZTS Absorbance:**




**Conclusion:**

Changes in the composition of CZTS nanoparticles seem to have a direct effect on their absorbance. This suggests that the band gap of the particles is changed with variations in composition. However, further characterization of the electronic properties of the CZTS nanoparticles is needed to conclusively determine dependence of band gap on composition. The results of this research are currently being used for patent applications.