

Supporting information

Facile one-pot synthesis of $\text{Cu}_2\text{ZnSnS}_4$ quaternary nanoparticles with microwave-assisted method

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Characterizations of the as-synthesized CZTS nanoparticles without annealing :
Microwave-assisted synthesized nanoparticles without annealing were subjected to the following analysis for their materials characterization. The structural properties of the materials were studied using X-ray diffraction method. The surface morphology of the annealed powder is observed using field emission scanning electron microscopy (FE-SEM). Raman spectroscopy was applied to scrutinize the characteristic vibrational bonding of the material.

A. Yield of the CZTS powder

Collected CZTS materials in one batch is 0.146 g

$$\text{CZTS}_{\text{real}} (\text{g}) = 0.146 \text{ g} \quad \text{M. W of CZTS} = 439.4$$



$$(\text{Cu}_2:\text{Zn}:\text{Sn}:\text{S}_4=0.75 \text{ mmol} : 0.375 \text{ mmol} : 0.375 \text{ mmol} : 2 \text{ mmol})$$

$$\text{CZTS}_{\text{theory}} (\text{g}) = 0.375 \times 10^{-3} \times 439.4=0.165 \text{ g}$$

$$\text{Yield} (\%) = 0.146 / 0.165 \approx 88\%$$

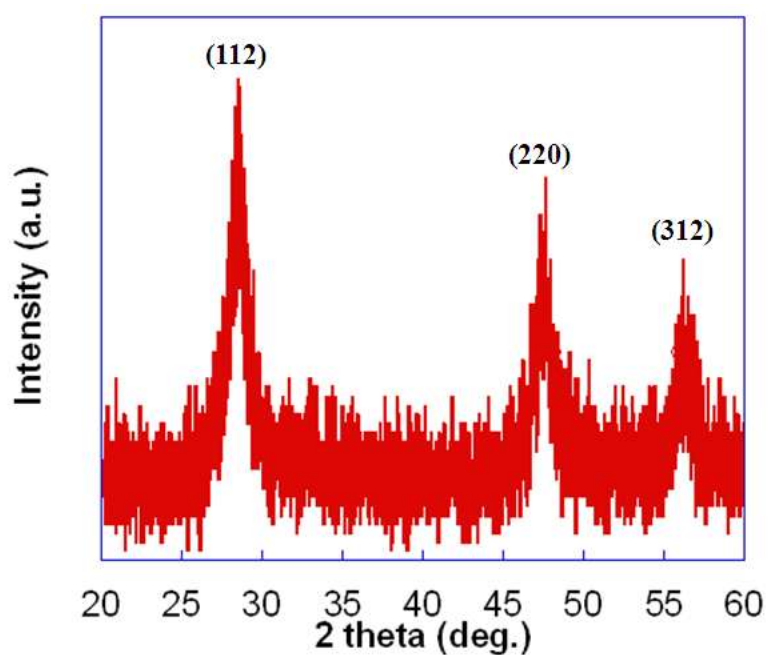


Figure S1 .The XRD images of CZTS crystals as-synthesized after microwave reaction. (Without annealing)

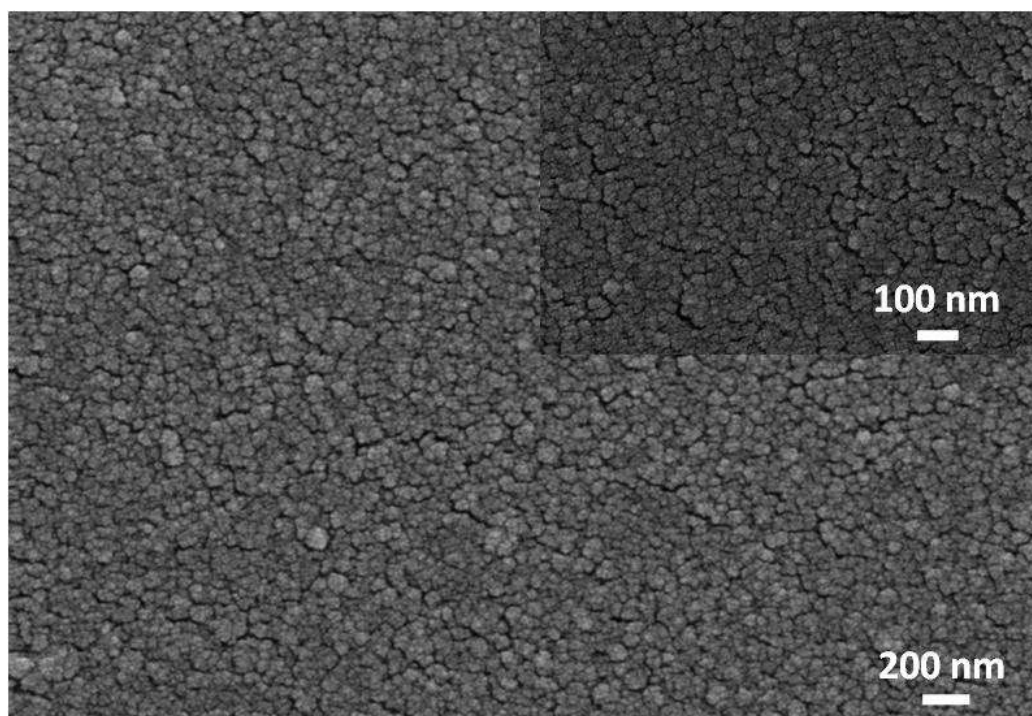


Figure S2 . The SEM images of CZTS crystals as-synthesized after microwave reaction.

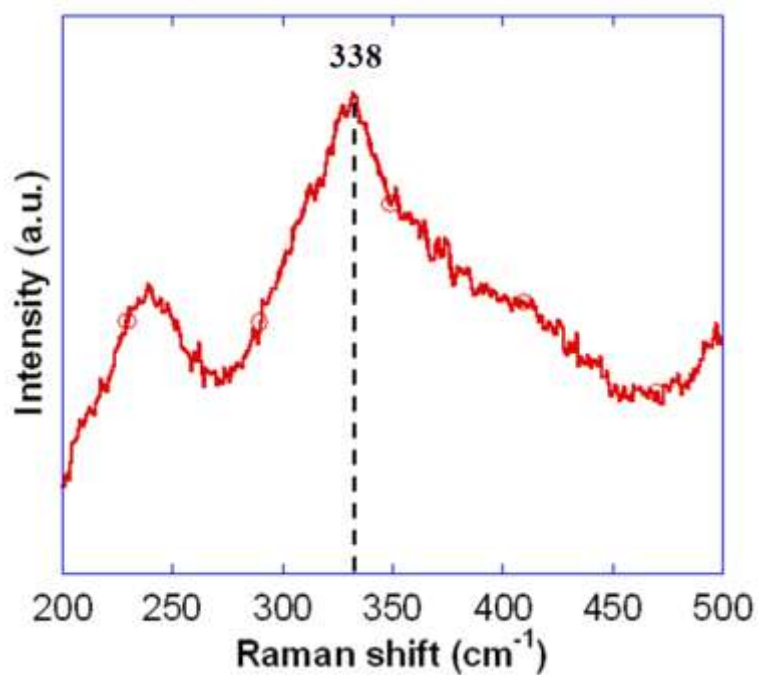


Figure S3 . The Raman images of CZTS crystals as-synthesized after microwave reaction.

Particle size characterization by DLS.

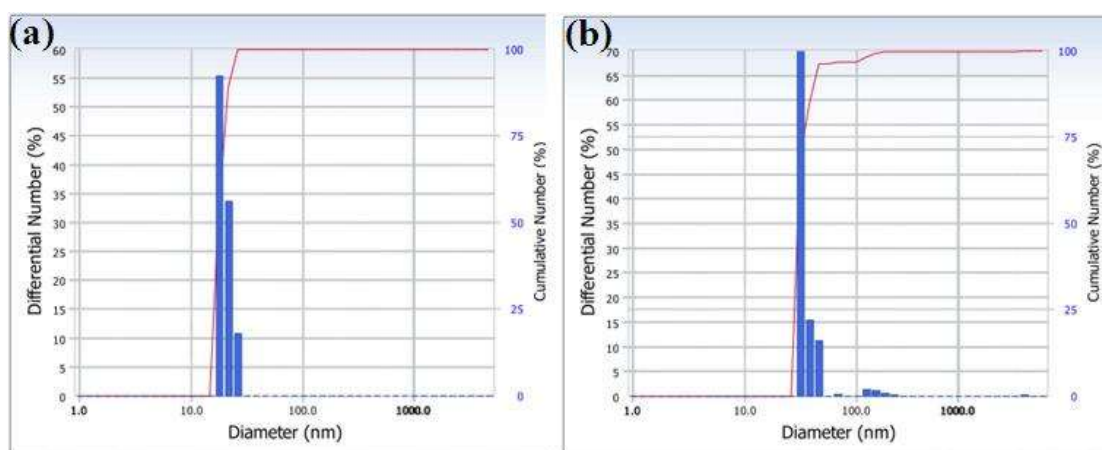


Figure S4. The size distributions of CZTS annealed (a) in glove box and (b) by sulfurization.

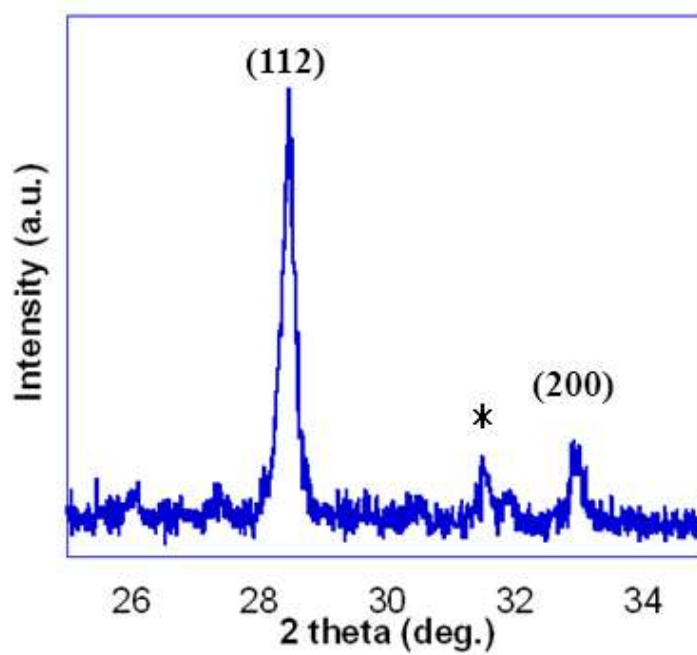


Figure S5. XRD pattern ranging from 25 to 35 degree of CZTS annealed in GB.

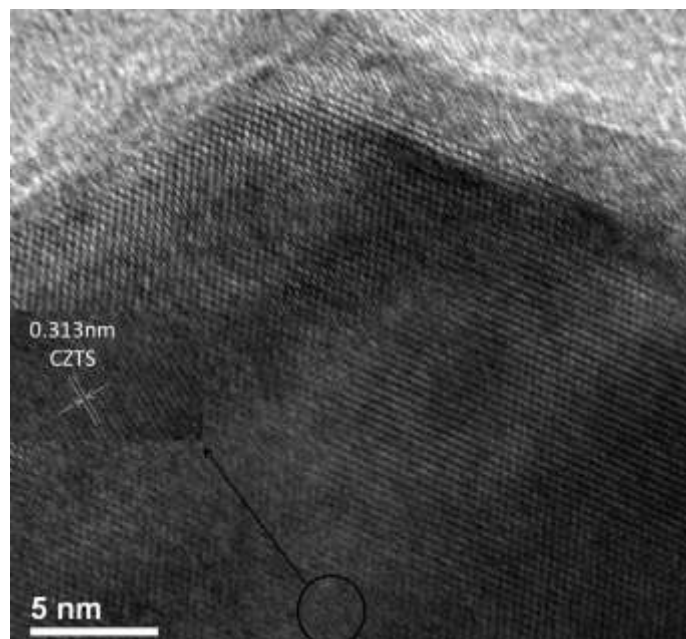


Figure S6. The high-resolution TEM image showing the lattice fringes of CZTS nanocrystal annealed in GB.