Supporting Information

Plasma-enhanced Microwave Solid-state Synthesis of Cadmium Sulfide: Reaction Mechanism and Optical Properties

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Chemical: The Cadmium powder (-200 mesh, 99.99%), sulfur pieces (Puratronic, 99.9995%), selenium powder (200 -mesh, 99.999%)，tellurium powder (200 -mesh, 99.5%), zinc flake (-325 mesh, 99.9%) and iodine spheres (ultra dry, 10 -mesh, 99.998%) were all purchased from the Alfa Aesar company. All elements were purchased in form of powders delivered and stored in glass bottles. Therefore, powders could be slightly surface oxidized. The content of oxygen in the powders, used for reactions, is not defined by vendors and was not analyzed by us. However, we detected some traces of CdO and $Cd(OH)_2$ in powder diffraction spectra.

PMPVT experiments: All of the reagents were used without further purification. Fine powders of respective metals and chalcogens were mixed and sealed in a quartz ampoule (approximately 100~200 mg of mixture). The length of the quartz ampoule is about 8~9 cm with the 13 mm external diameter. The ampoule was filled with Ar gas and the pressure inside could be controlled from 1×10^{-4} Torr to 750 Torr. The optimized pressure is 10 Torr. Then, the ampoules were placed in a quartz tube that was located in the center of a modified domestic microwave oven (2450 MHz, 1 kW) without any additional conventional heating. The argon gas with about 5 ~ 10 Torr pressure flowed through the evacuated quartz tube. When the microwave oven was

running, the argon plasma in the quartz tube was ignited and could be seen. After 2~4 hours, most of the reactions were complete.

PMCVT experiment: The PMCVT experiment was very similar with PMPVT. The only different was that the iodine (about 8 mg) was added as transport chemical in the starting mixture. The Cd:S:I ratio is about 16: 1. We kept the PMCVT for 4 hours to get the fully reacted product.

Physical measurement: PXRD patterns were collected by a Bruker D8 Advance diffractometer using Cu$K\alpha$ (1.54178 Å) radiation in the angular range of 2θ = 5-75° at room temperature. SEM images and EDX were obtained from a JEOL JSM 7600F scanning electron microscope. Both the laser beams (solid-state laser, 473 nm and Nd:YAG solid-state laser, 532 nm) were collimated and focused thorough a 100× objective onto the sample surface. All of the spectra were collected using a confocal triple-grating spectrometer (Horiba-JY T64000). The reflectance was collected by CRAIC 20 Microspectraphotometer and converted to absorbance using the Kubelka - Munk equation.[1] The PL spectrum was fitted by a Gaussian function in Origin software, whereas the baseline-subtracted Raman peaks were fitted by a Lorentzian function. The Raman baseline was fitted by a line function. The simulated PXRD pattern through single crystal data was generated by Mercury 2.3 software.

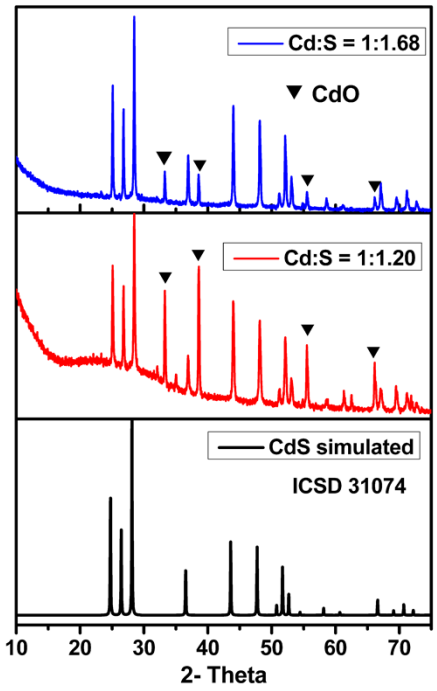


Fig. S1.PXRD of the products with different ratio of Cd:S in 2h reaction.

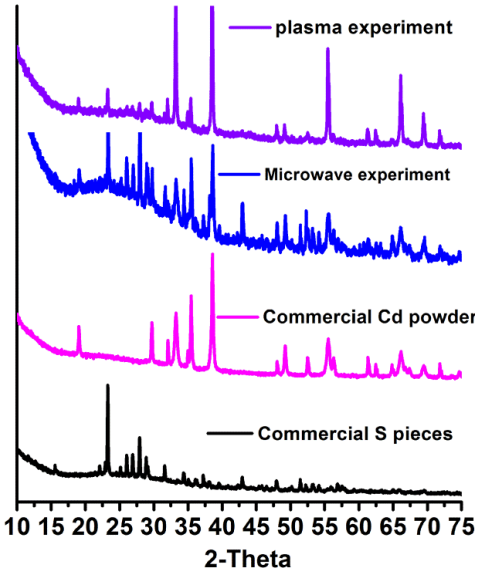


Fig. S2. The PXRD of the products under different conditions.

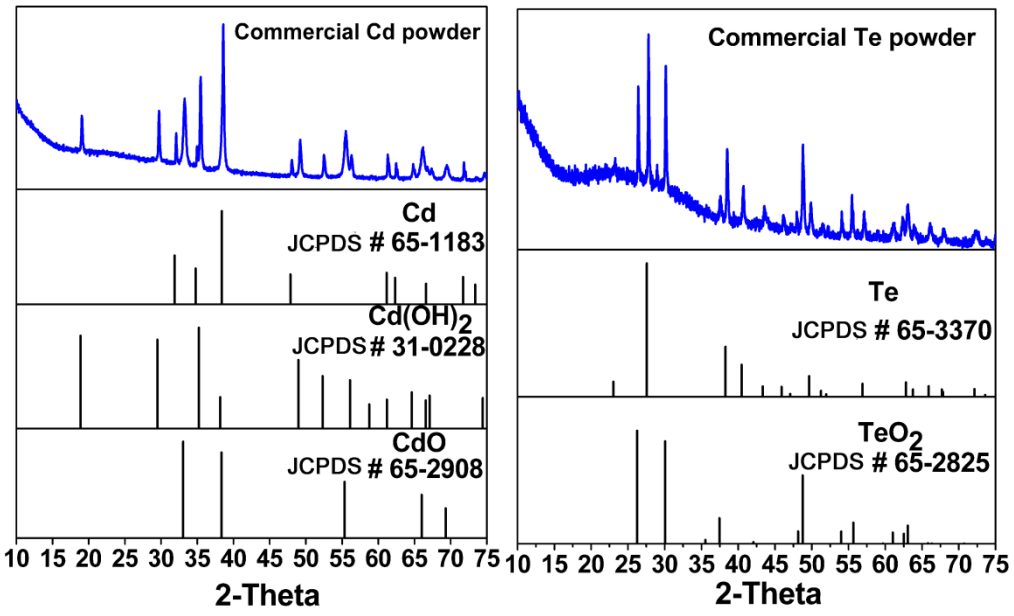


Fig. S3. The PXRD of commercial Cd and Te powder.

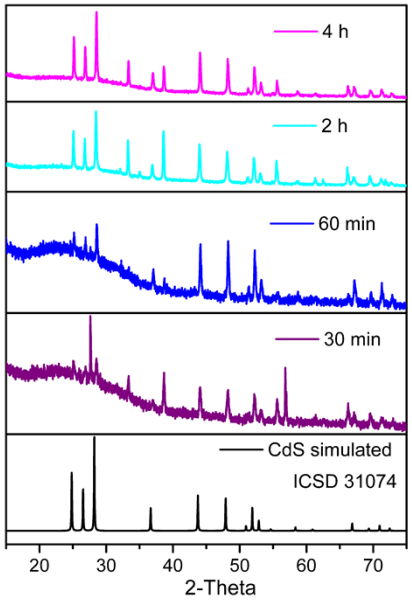


Fig. S4. The effect of reaction time.

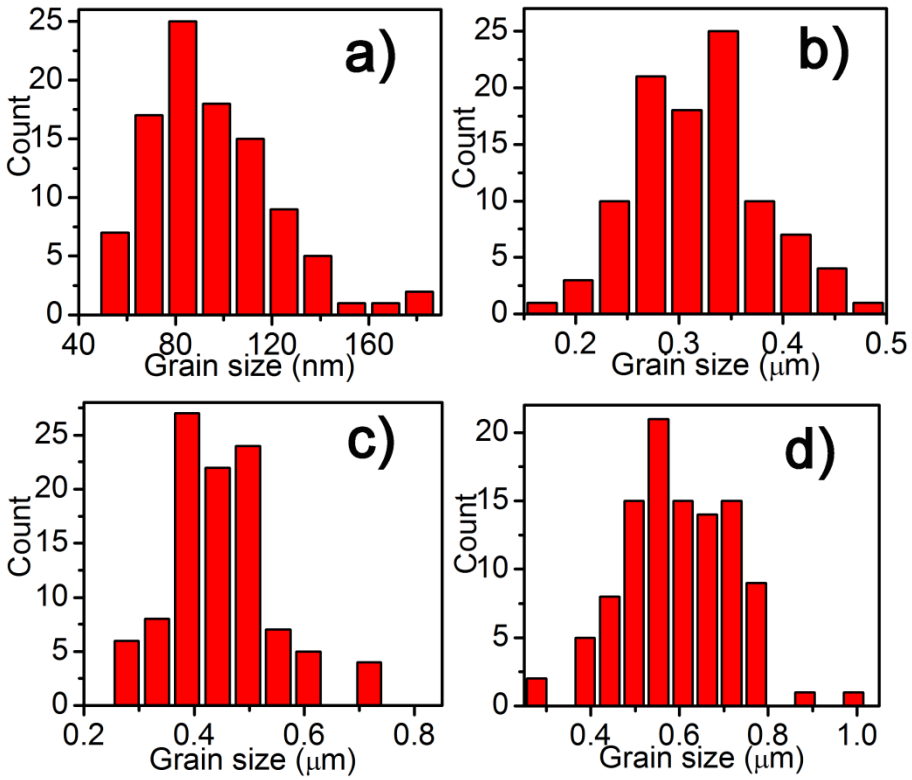
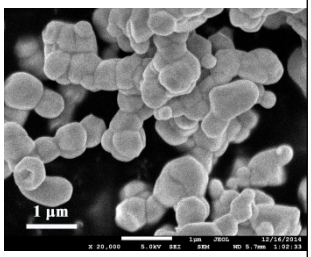
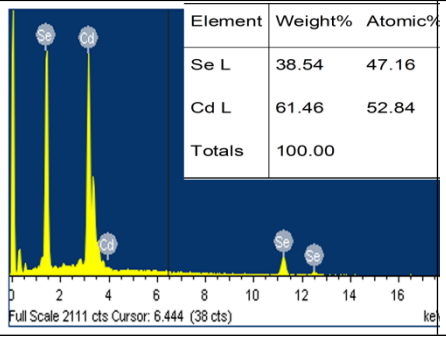
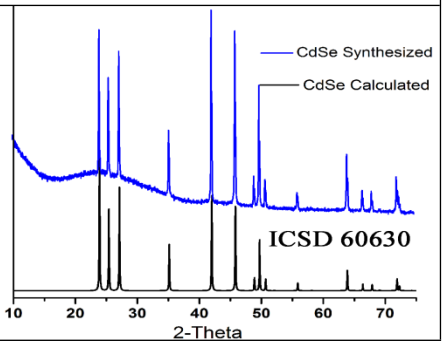
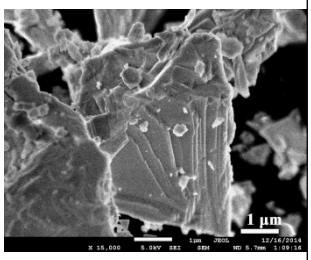
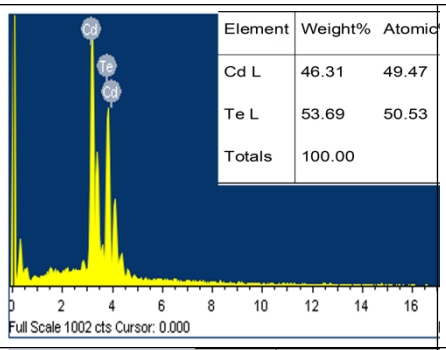
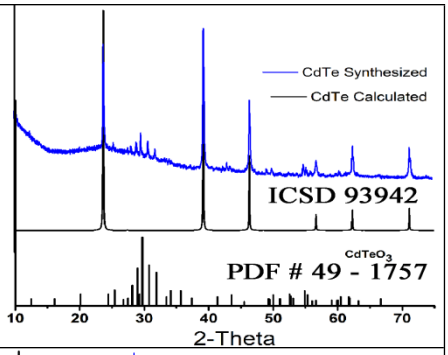
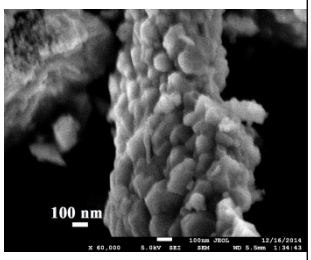
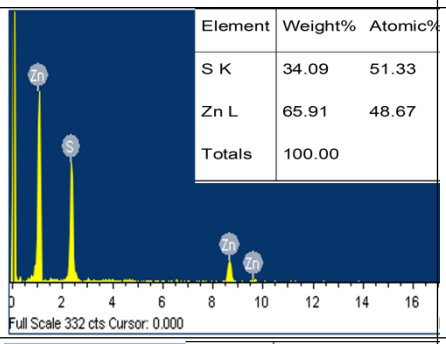
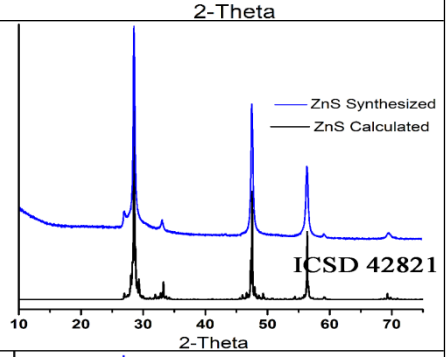
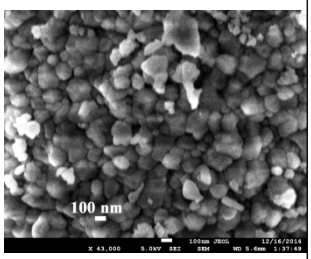
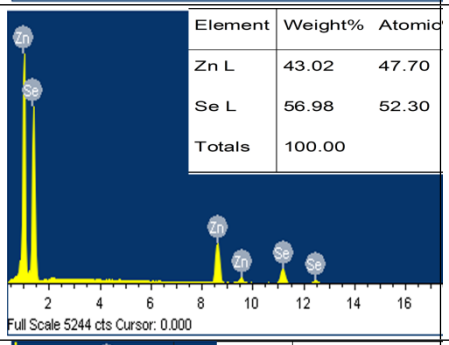
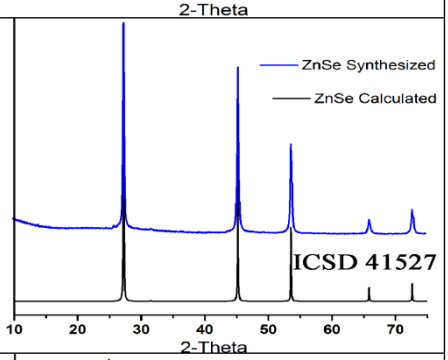
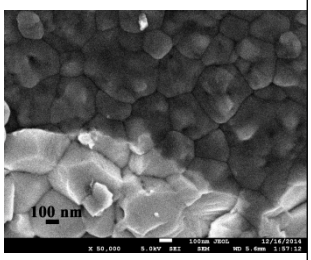
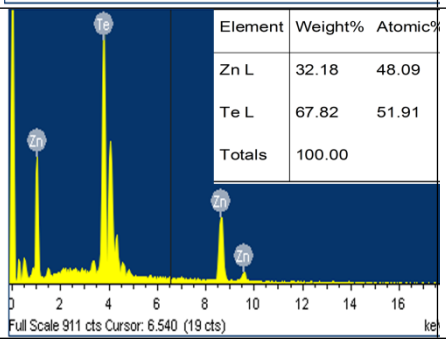
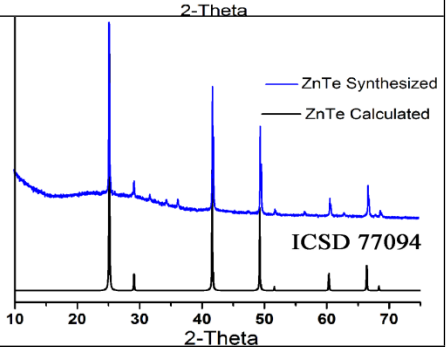


Fig. S5. Time dependent grain size distribution of CdS synthesized by PMPVT, a) 30 min; b) 60 min; c) 120 min and d) 240 min.

Table S1 SEM images, EDX and PXRD patterns of other II-VI chalcogenides synthesized by PMPVT. The blue curve in the XRD results is the experimental pattern, wherea the black one is the related theoretical one.

	SEM	EDX	PXRD
CdSe			

CdTe			
ZnS			
ZnSe			
ZnTe			

1. Nobbs, J. H., Kubelka—Munk Theory and the Prediction of Reflectance. *Color. Technol.* **1985,** *15* (1), 66-75.