Synthesis of CdTe Quantum Dots - Influence of Microwave Irradiation on the Nanocrystals Size and Optical Properties

R. Milani[1,2], F.D. Menezes[3], S. Alves Junior[1], M. de la Mata[4], J. Arbiol[4,5], J. Albino Aguiar[1,6] and G. Machado[1,2*]

[1] PGMTR/CCEN, Universidade Federal de Pernambuco, PE, Brazil
[2] CETENE, Centro de Tecnologias Estratégicas do Nordeste, PE, Brazil
[3] CRCN, Centro Regional de Ciências Nucleares, PE, Brazil
[4] ICMAB-CSIC, Institut de Ciència de Materials de Barcelona, CAT, Spain
[5] ICREA, Institució Catalana de Recerca i Estudis Avançats, CAT, Spain
[6] Departamento de Física, Universidade Federal de Pernambuco, PE, Brazil
*giovanna@cetene.gov.br

The search for simplification of the experimental procedures and synthesis in aqueous solution of semiconductor nanocrystalline materials has attracted increasing interest due to the innovative technological applications offered by these materials. Currently, semiconductor quantum dots (QDs) are used in optoelectronics, photovoltaic and biomedical devices. It is even used in imaging diagnostic and marking diseased cell structures within the human body [1]. These materials exhibit peculiar properties compared to traditional materials. Besides showing strong luminescence, its properties are not uniquely determined by the chemical composition, but by the dot size. Changing the quantum dots size produces radical variations in the emitted light color. Thus quantum dots of the same material, however with different sizes, can emit different light colors [2]. In this work, we propose a simple, fast and efficient methodology to control the optical properties and growth of CdTe quantum dots by microwave irradiation. The CdTe quantum dots used in this study were obtained in aqueous solution by a methodology recently described [3]. Subsequently the QDs were grown using an assisted microwave method. According to the grown temperature, CdTe QDs with different particle size and fluorescence energy were obtained. The colloidal suspension pH for all samples used in this work was 9.5. The samples were characterized by UV-Vis and fluorescence spectroscopy, TEM and HRTEM. Figure 1 shows the UV-Vis absorption, fluorescence spectra and emission color for different aqueous colloidal dispersions of the synthesized CdTe nanocrystals. In Figure 1a one can observe that there is a considerable displacement of the optical absorption band from 468 nm (green line) to 552 nm (red line) for the particles studied. Similarly, in Figure 1b, it is evident the displacement of the emission bands toward longer wavelengths from 518 nm (original sample) to 590 nm (last sample). Figure 1c shows the change of emission color from green to red by different colloidal dispersions of CdTe. The shift in the absorption and emission bands peak position signalized that the obtained CdTe QDs nanocrystals have different sizes. The larger the dot, redder (lower energy) is the fluorescence spectrum. Conversely, smaller dots emit green (higher energy) light. The average particle size was determined by TEM and crystal structure was confirmed by HRTEM. Figure 3 and Figure 4 present HRTEM images of the CdTe QDs. It is observed that the size of nanocrystals ranging from 2 to 6 nm [4].

References

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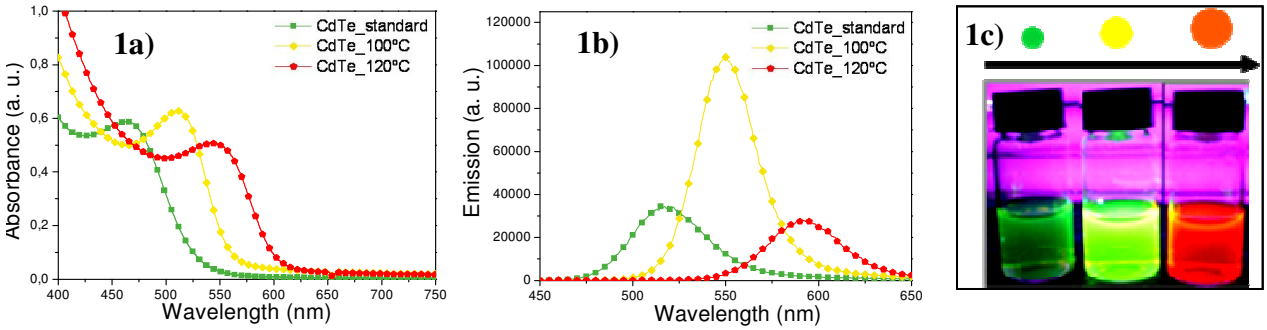

FIG. 1. UV-Vis absorption spectra (a) and fluorescence spectra (b) of CdTe QDs samples irradiated by microwave in different temperature. The green square correspond to the standard sample, while the yellow diamond and red pentagon correspond to the sample irradiated by microwave during 1 minute at 100ºC and 120ºC, respectively. (c) Images of aqueous colloidal dispersions of CdTe QDs illuminated by UV light. It's evident the change of emission color according with the nanocrystals size.

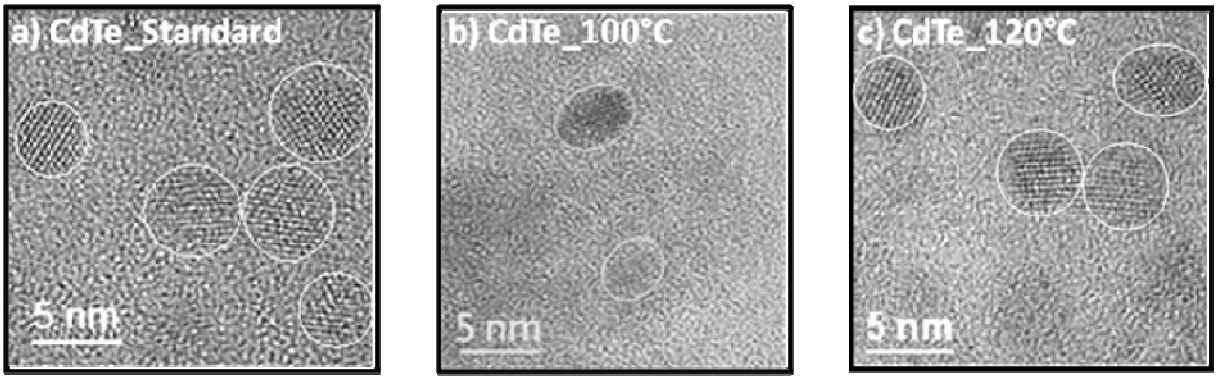

FIG. 3. HRTEM images of the CdTe QDs samples. (a) Image of the standard sample. (b) and (c) image of the samples irradiated by microwave during 1 minute at 100ºC and 120ºC, respectively.

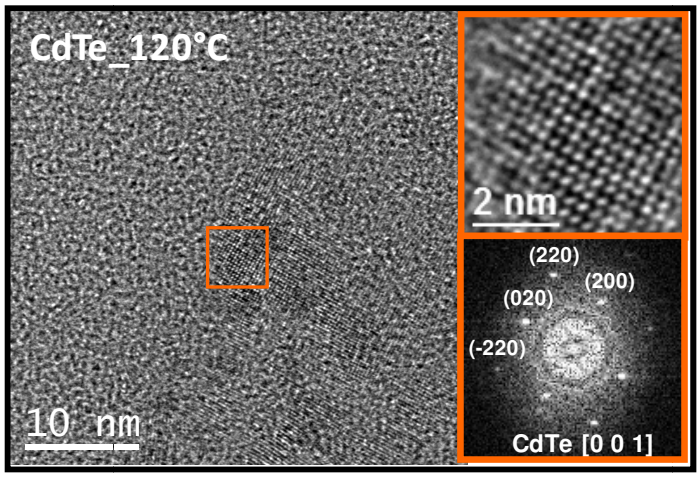

FIG. 4. TEM image of the sample irradiated by microwave during 1 minute at 120ºC and its correspondent indexed power spectrum (FFT obtained from the HRTEM image).