

## Biotemplated Synthesis of CdSe Nanowires

**Sarang S N\***

Institute of Physics, P.O. - Sainik School, Sachivalaya Marg, Bhubaneswar-751005, India

**\*Corresponding author:** Sarang S N, Institute of Physics, P.O. - Sainik School, Sachivalaya Marg, Bhubaneswar-751005, India, Email: sachin@iopb.res.in

### Mini Review

Volume 3 Issue 2

**Received Date:** May 25, 2018

**Published Date:** June 08, 2018

**DOI:** 10.23880/nnoa-16000140

### Abstract

The use of bio-molecular building blocks opens a new direction in the realm of nanotechnology and such a technology is essential to manipulate nanocrystals in its shape and size. Nucleic acids are of special interest for its ability of self-organization and sensitivity to biological process. In the present work, we present an approach of organizing bioinorganic nanostructures. CdSe nanowire has been synthesized using single strand oligonucleotides as a biotemplate by an electrodeposition technique. A comparative study conducted between CdSe nanoparticle and biotemplated CdSe-DNA nanowire. The CdSe-DNA nanowire reveals a cubic phase as revealed from X-Ray diffraction measurement. CdSe nanowires are fabricated in a filamentary, wire like morphology in DNA strand as established from Atomic Force Microscopic (AFM) measurements.

**Keywords:** Nanowires; Electrodeposition Technique; Nanoparticles; Oligonucleotides

**Abbreviations:** AFM: Atomic Force Microscopic; ITO: Indium Tin Oxide

### Introduction

Hybrid systems based on semiconductor quantum dots attached to biomolecules find increasing attention in the development of nanobiotechnology [1-3]. Many experimental approaches have been made to fabricate nanorods by template driven synthesis using chemical routes [1,2]. However, the electrochemical approach to fabricate semiconductor nanorods using DNA as the template is promising because of its simplicity in depositing the material directly on a conducting substrate. Presence of negatively charged phosphate group in the DNA backbone gives the polyelectrolyte nature to it. Such a polyelectrolyte can interact with positively charged ions and make them ideal templates to grow nanoparticles [4,5]. Thus, such nanoparticles tag with DNA can produce nanostructures, which are of interest to biosensor applications [6,7]. The present work

reports a novel and simple strategy to grow CdSe nanobiorods using (Oligo) single stranded DNA (ssDNA) and its complementary DNA as a template by an electrodeposition technique. The surface, morphology and structural properties have been studied by using Atomic Force Microscopy (AFM) and X-ray Diffractometry (XRD) technique.

### Synthesis

CdSe-DNA nanowire thin films were deposited onto Indium Tin Oxide (ITO) conducting glass substrates by an electro-technique cathodic deposition under galvanostatic condition from a solution containing CdSO<sub>4</sub> (0.92 M), SeO<sub>2</sub> (0.018 M), and ssDNA, Guanine (Poly-G- 60base pair) and oligonucleotides ssDNA, Cytosine (Poly-C- 60base pair) at room temperature [7]. Typically the electrolysis current density was 5mA/cm<sup>2</sup> and the deposition time was kept as 2 minute to synthesize CdSe-DNA complex nanowires. Two samples were prepared for the investigation, namely, sample S1, CdSe nanocrystals

(NCs) without DNA and sample, S2, CdSe nanowire with DNA. The morphology and structural properties of samples were investigated by Atomic Force Microscopic (AFM), and X-ray diffraction XRD where X-ray diffractometer equipped with a monochromatic  $\text{CuK}\alpha$  radiation source ( $1.54178\text{\AA}$ ).

## Results and Discussion

The XRD patterns of CdSe nanocrystalline (S1) and CdSe-DNA complex (S2) are shown in Figure 1. Structural

analysis shows the XRD peaks at  $2\theta = 25^\circ$ ,  $42^\circ$ , and  $49^\circ$  corresponds to the prominent planes (111) and (220) and (311), confirms the polycrystalline cubic phase in the deposit for both the samples. The peaks marked with a \* corresponds to the X-Ray diffraction peaks of ITO substrate in both the sample. Note that for sample S1, the X-ray peak intensities are weak and broad compared to the CdSe-DNA complex suggesting the S1 crystallite sizes are small. Since the CdSe-DNA complex shows a wire like structure (discussed in the latter section), the observed XRD spectra shows intense X-ray peak intensities and narrow peak similar to bulk CdSe materials.

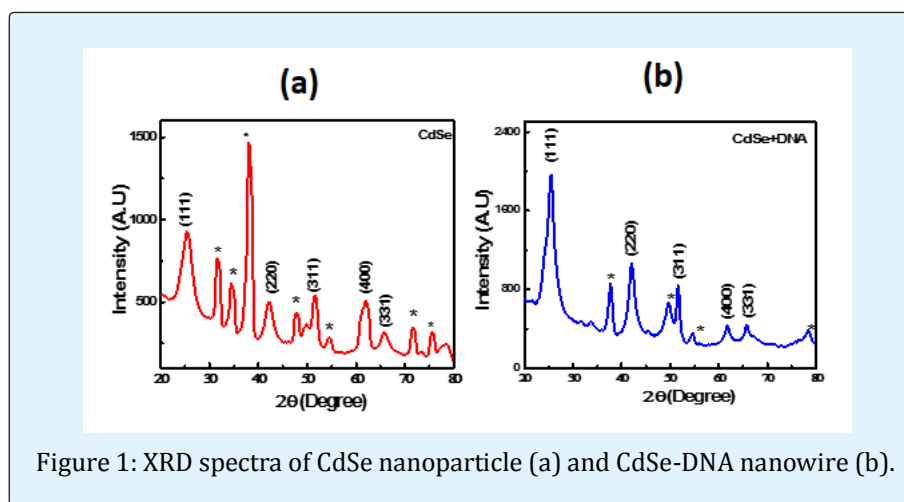


Figure 1: XRD spectra of CdSe nanoparticle (a) and CdSe-DNA nanowire (b).

The AFM images of CdSe nanoparticle and CdSe-DNA complex nanowire are shown in Figure 2. As shown in Figure 2 (a), a size distribution present in CdSe material and they are of nanoparticle form. The surface of the sample is rough due to presence of nanocrystalline particle. Similarly, sample CdSe-ssDNA complex (S2) reveals a filamentary, netlike structure and represents

nanowire morphology as marked in dotted line in figure 2(b). The explanation for nanowire formation using ssDNA and its conjugate is that, initially the CdSe nanocrystals are tagged to ssDNA along its string then the interdiffusion of CdSe nanocrystals with its conjugate DNA make the whole system rigid to form a nanowire.

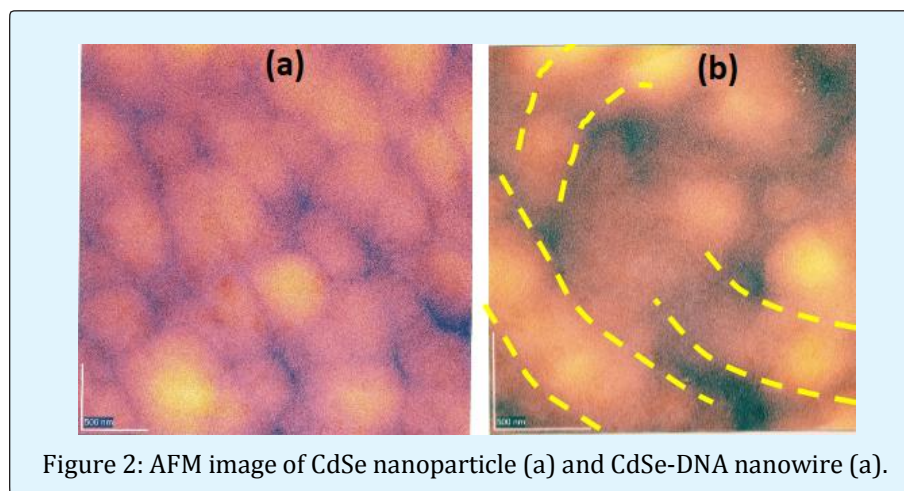


Figure 2: AFM image of CdSe nanoparticle (a) and CdSe-DNA nanowire (a).

## Conclusion

Biotemplated synthesis of CdSe nanowire is possible using single strand oligonucleotides (ssDNA) and its conjugate. The CdSe-DNA nanowire have been grown by an electro-deposition technique. XRD results identify the presence of cubic phase in both CdSe nanocrystal and biotemplated CdSe-DNA nanowire. The AFM results identify the shape of the CdSe in nanoparticle form whereas the shape of biotemplated CdSe-DNA complex is in nanowire form.

## Acknowledgement

The author is grateful to the late Professor S. N. Sahu then at Institute of Physics for his support on this work.

## References

1. Bruchez M, Moronne M, Gin P, Weiss S, Alivisatos AP (1998) Semiconductor nanocrystals as fluorescent biological labels. *Science* 281(5385): 2013-2016.
2. Mattoussi H, Mauro JM, Goldman ER, Anderson GP, Sundar VC, et al. (2000) Self-Assembly of CdSe-ZnS Quantum Dot Bioconjugates Using an Engineered Recombinant Protein. *J Am Chem Soc.* 122(49): 12142-12150.
3. Sarangi SN, Sahu SN, Nozaki S (2018) *Physica E: Low-dimensional Systems and Nanostructures* 97: 64-68.
4. Braun E, Eichen Y, Siran U, Ben-Yoseph G (1998) DNA-templated assembly and electrode attachment of a conducting silver wire. *Nature* 391(6669): 775-779.
5. Coffey JL (1997) Approaches for Generating Mesoscale Patterns of Semiconductor Nanoclusters. *J Cluster Science* 8(9): 159-178.
6. Sirota M, Minkin E, Lifshitz E, Hensel V, Lahav M (2001) Spectroscopic Properties of Molecular-Wire/Semiconductor Nanocrystalline Superstructure s. *J Phys Chem* 105(29): 6792-6797.
7. Sarangi SN, Goswami K, Sahu SN (2007) Biomolecular recognition in DNA tagged CdSe nanowires. *Biosens Bioelectron* 22 (12): 3086-3091.