

# Supercritical Synthesis and Characterization of Graphene-PbS Quantum Dots Composite with Enhanced Photovoltaic Properties

Ahmad Tayyebi<sup>1</sup>, Mohammad Mahdi Tavakoli<sup>2,3</sup>, Mohammad Outokesh<sup>1</sup>, [Azizollah Shafiekhani](#)<sup>4</sup>  
Abdolreza (Arash) Simchi<sup>2</sup>

<sup>1</sup> Department of Energy Engineering, Sharif University of Technology, Azadi Avenue, P.O. Box 113658639, 14588 Tehran, Iran.

<sup>2</sup> Department of Materials Science and Engineering, Sharif University of Technology, 14588 Tehran, Iran.

<sup>3</sup> Department of Electronic and Computer Engineering, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon 999077, Hong Kong.

<sup>4</sup> Department of Physics, Faculty of Physics and Chemistry, Alzahra University, Vanak, Tehran, Iran.

## Abstract

Lead sulfide quantum dots (PbS QDs) were decorated onto a graphene surface in a semi-core-shell structure using supercritical ethanol. The temperature of ethanol played significant role in controlling size and agglomeration of QDs as well as the extent of reduction of graphene. Average size of the QDs was estimated by transmission electron microscopy to be around 3.96 nm and by quantum models to be about 4.34 nm. PbS QDs prepared at 330 °C were of high purity, and the yield was 99%. Instrumental and chemical analyses demonstrated formation of a strong bond between PbS QDs and graphene, through a Pb-O-C bridge. UV and photoluminescence measurements along with theoretical considerations revealed that integration of PbS QDs with graphene results in efficient separation of the electron-hole, thus enhancing photo → electric energy conversion. This outcome was further evidenced by comparison of performance of PbS/G in a solar cell, with the performance of pristine PbS QDs.