Asian Journal of Engineering and Applied Technology
ISSN: 2249-068X (P) Vol.10 No.2, 2021, pp.34-38

DOI: https://doi.org/10.51983/ajeat-2021.10.2.3073

A New Viewpoint and Outlook on Aryl Mercaptans as Strong Nucleophiles with Various Chain Length Linked to DNA/RNA and Cadmium Oxide (CdO) Nanoparticles Sandwiched Complex

Alireza Heidari
Faculty of Chemistry, California South University, Irvine, California, USA
E-mail: scholar.researcher.scientist@gmail.com
(Received 9 July 2021; Accepted 17 August 2021; Available online 25 August 2021)

***Abstract* - CdO nanoparticles show a strong peak of Plasmon absorption in ultraviolet–visible zone. A strong interaction exists between the surface of CdO nanoparticles and aryl mercaptan compounds. Aryl mercaptan compounds cause to aggregation of CdO nanoparticles linked to DNA/RNA and hence, lead to widening of peak Plasmon of CdO nanoparticles surface at 550 (nm) and emerging a new peak at higher wavelength. In the current project, this optical characteristic of CdO nanoparticles is used to time investigate the interaction between different aryl mercaptanes and CdO nanoparticles. The results were shown that aryl mercaptan compounds with shorter chain length interact faster with CdO nanoparticles. Therefore, a simple and fast method for identification of aryl mercaptanes with various chain length using red shift in surficial Plasmon absorption is presented.**
***Keywords:* Aryl Mercaptans, Peak Plasmon Absorption, Aggregation, CdO Nanoparticles, DNA/RNA**

I. INTRODUCTION

Investigations about CdO nanoparticles are widely developed due to their considerable optical characteristics and potential application in optical devices, sensors and optical circuits specially in diagnostic and treating medical sciences [1]. CdO nanoparticles show a strong absorption peak in ultraviolet–visible zone when interact with light. The maximum position of spectrum depends on size, form, inter–particle space and de–electric environment of nanoparticles [2].

There is a high affinity between aryl groups and CdO nanoparticles which leads to aggregation of CdO nanoparticles linked to DNA/RNA. As a result of this aggregation, the Plasmon absorption peak of CdO nanoparticles widen at 550 (nm) and a new peak emerges at higher wavelength. Numerous researches have been performed about CdO nanoparticles aggregation linked to DNA/RNA and application of this characteristic of CdO nanoparticles for identification of target analytes and producing sensors [3].

In a research, chemical absorption of aryl mercaptans on CdO colloid at the presence of sodium hydroxide was investigated; the results were shown that the largeness of these changes depends on pH, chain length and the end of aryl mercaptans chain [4]. At another research, the effective factors on controlling the optical characteristics of CdO nanoparticles aggregation linked to DNA/RNA including oligonucleotides linked with various lengths (72–24 pairs) were studied.

This test shown that optical characteristics of DNA/RNA aggregation linked to CdO nanoparticles are controlled with size of aggregation and ignoring the chain length of oligonucleotides which is important for colorimetric identification based on nanoparticle, it was shown that optical effects are more dependent to size of aggregation which in turn, it is under kinetic control [5]. The rate of band change of surface Plasmon is conversely related to the length of DNA/RNA connections so that 24 chains systems (shortest) have shown the highest change in rate [6].

Mercaptanes are important compounds in chemical synthesize environment, gas and petrochemical industries and biology [7]. In the current research, optical characteristic of CdO nanoparticles is used to time identification of aryl mercaptanes with various chain length. In previously used methods for identification of mercaptanes in petrochemical and oil industry, only total mercaptan could be identified; however, the current method can identify mercaptanes with various chain lengths which is very important for making sensors of these compounds [8].

II. MATERIALS AND EXPERIMENTAL METHODOLOGY AND TECHNIQUES

A. Preparing CdO Nanoparticles and Description of CdO Nanoparticles Aggregation Linked to DNA/RNA

All glass wears used in this test was washed with a solution of HCl: HNO_3 with concentration ratio of 3:1 and then, with deionized water and acetone and afterwards, dried in air. In this project, Terkovic method was used for synthesizing the CdO nanoparticles. A 0.05 (gr) of hydrogen tetra coloro–urate ($HCdCl_4$, $3H_2O$) was solved in 100 (ml) of water and then, was indirectly heated under 150ºC temperature and stirring rate of 500 (rpm) in a balloon connected to a cooler.

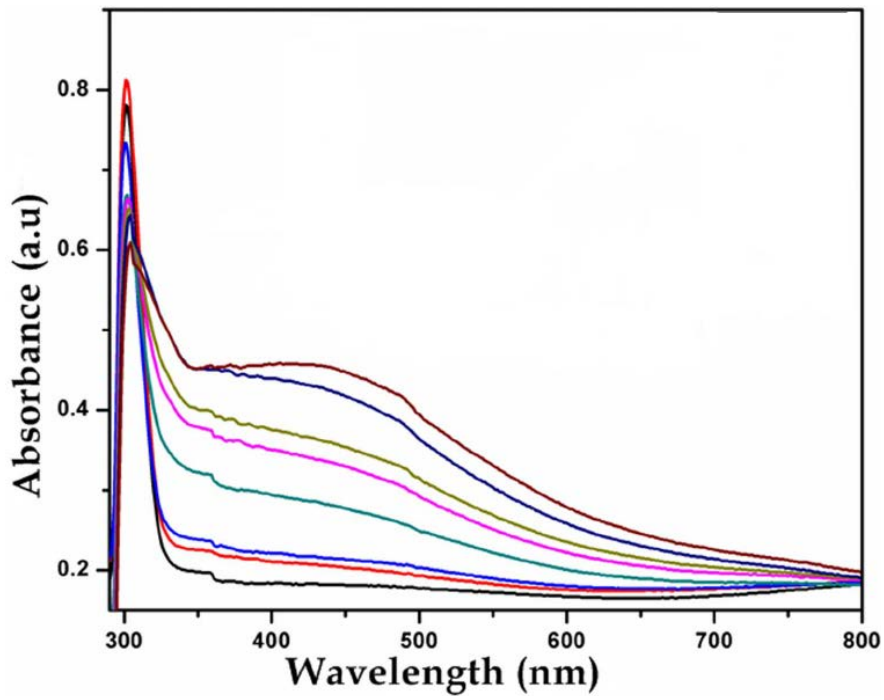
When CdO solution was boiled, 2.5 (ml) solution of sodium citrate of 0.05 (M) was added and the colloidal solution of

CdO was gradually produced with reduction of CdO ions (III). The color of initial solution was mellow yellow. The color of this solution was gradually changed to blue, violet and dark red. At the end of test, the color was dark red. The size of produced nanoparticles was 25 (nm). The size of CdO nanoparticles was determined by DLS.

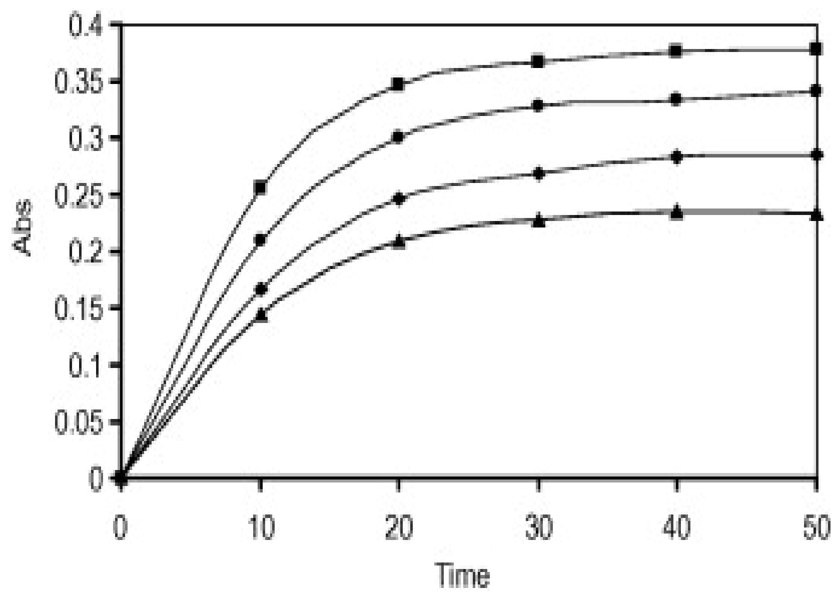
In order to time investigate the interaction of CdO nanoparticles, aryl mercaptanes with various lengths were added to CdO nanoparticles at room temperature.

III. RESULTS AND DISCUSSION

The absorption spectrum of CdO nanoparticles was recorded in various times with aryl mercaptans with various chain lengths as shown in Figures (1), (2) and (3). As can be seen in these figures, peak is decreased at 573 (nm) and a new peak is emerged at higher wavelength which gradually increased with time and after reaching to the maximum, the absorption decreases which is due to complete aggregation linked to DNA/RNA and instability of the produced CdO nanoparticles.

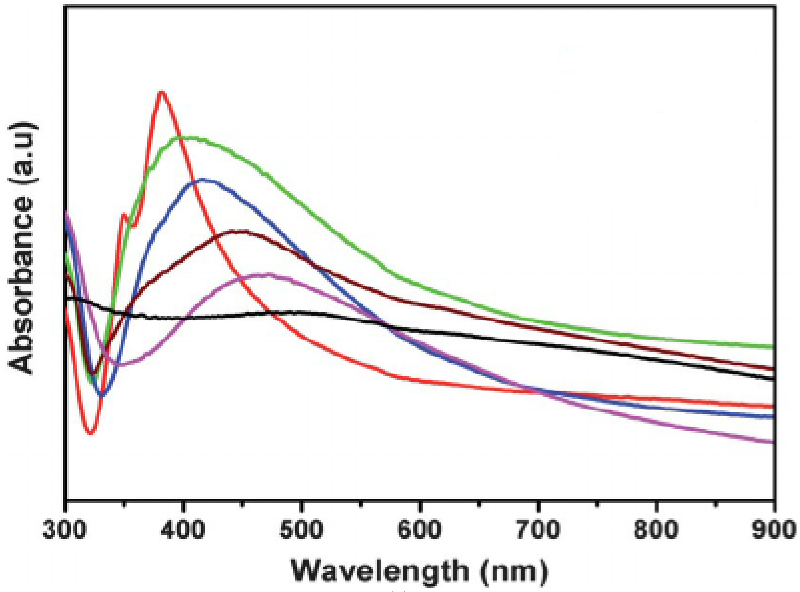


(a)

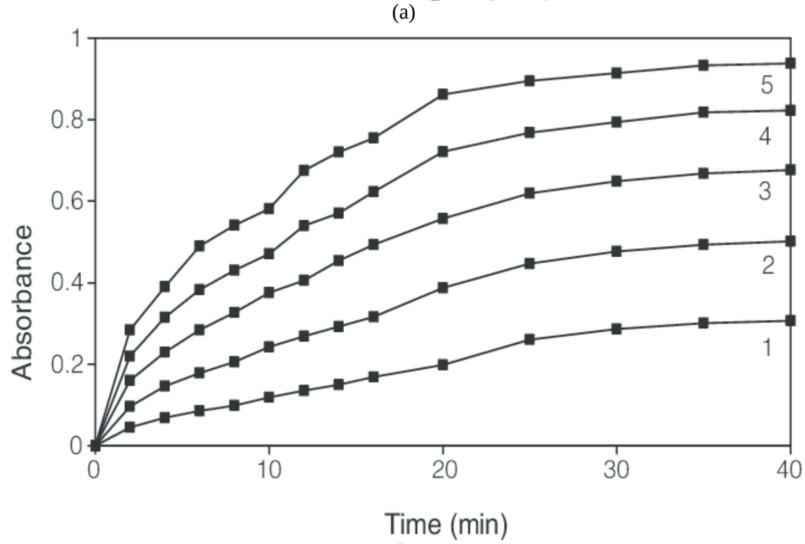


(b)

Fig. 1 (a) Absorption spectrum of CdO nanoparticles–phenyl mercaptan during 0–1200 (s)
(b) Absorption curve against time for CdO nanoparticles–phenyl mercaptan at maximum wavelength

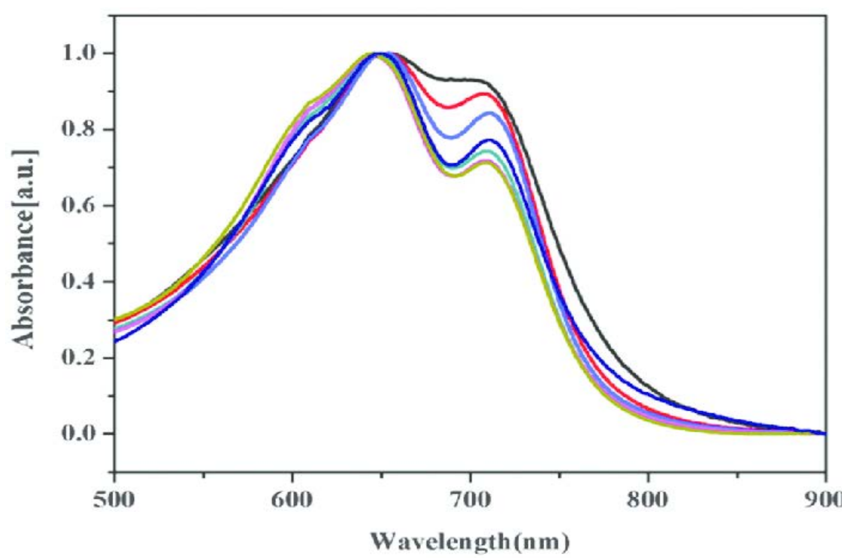


(a)

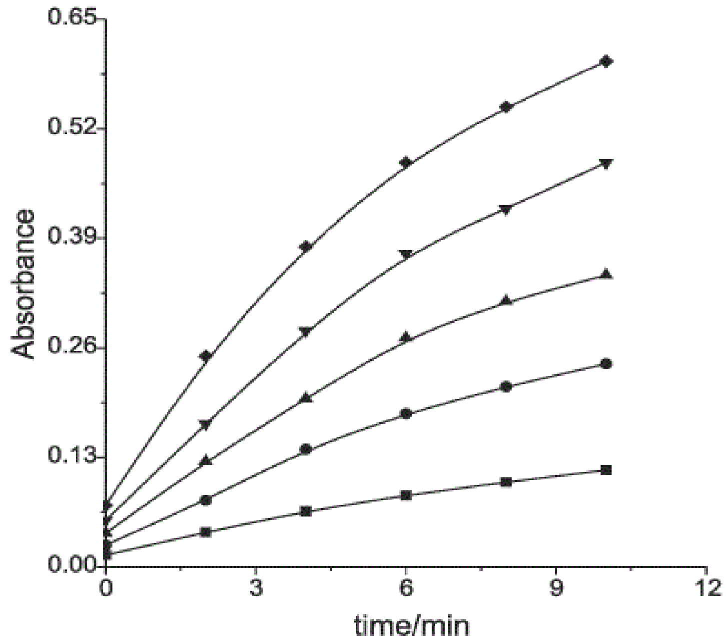


(b)

Fig. 2 (a) Absorption spectrum of CdO nanoparticles–benzyl mercaptan during 0–1200 (s)
(b) Absorption curve against time for CdO nanoparticles–benzyl mercaptan at maximum wavelength



(a)



(b)

Fig. 3 (a) Absorption spectrum of CdO nanoparticles–propyl mercaptan during 0–1200 (s)
(b) Absorption curve against time for CdO nanoparticles–propyl mercaptan at maximum wavelength

The results show that aryl mercaptanes with shorter chain length lead to faster aggregation of CdO nanoparticles linked to DNA/RNA than ones with longer chain length. In other words, at shorter time, CdO nanoparticles is aggregated with aryl mercaptanes with shorter chain length at higher wavelength compared to absorption spectrum of CdO nanoparticles aggregated with aryl chains with longer chain length. As can be seen in Figure (4), during 90 (s), phenyl mercaptanis emerged at higher wavelength (812.49 nm) than phenyl (777.91 nm) and pentylmercaptanes (a wide peak between 500–760 nm) and hence, aryl chains with various chain length can be identified through controlling the aggregation time.

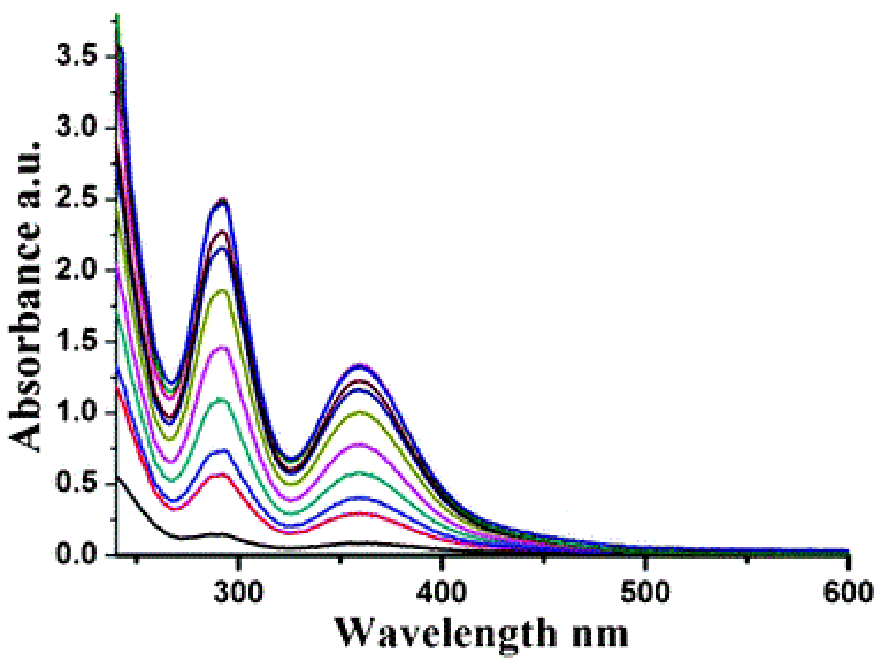


Fig. 4 Absorption spectrum of CdO nanoparticles with various aryl mercaptanes during 90 (s) (concentration of CdNPs is equal to 250 ppm and 2.5 ml used, phenyl mercaptan 60 nmol, phenyl mercaptan 45.5 nmol and phenyl mercaptan 55.5 nmol)

The optical difference for aggregation of aryl mercaptanes connected to chains with various lengths to CdO nanoparticles can be attributed to size of aggregation linked to DNA/RNA and inter–particle distance.

IV. CONCLUSION

In the current study, optical characteristics of peal Plasmon of absorption of CdO nanoparticles was used to identify mercaptanes with various chain length and through time controlling, they were identified successfully. It was observed that the second peak at wavelength between 500–760 (nm) induced by interaction of mercaptanes with CdO nanoparticles in aryl mercaptanes with shorter chain length at shorter time duration observe at higher wavelength than aryl mercaptanes with longer wavelength.

ACKNOWLEDGEMENT

This study was supported by the Cancer Research Institute (CRI) Project of Scientific Instrument and Equipment Development, the National Natural Science Foundation of the United Sates, the International Joint BioSpectroscopy Core Research Laboratory Program supported by the California South University (CSU), and the Key project supported by the American International Standards Institute (AISI), Irvine, California, USA.

REFERENCES

[1] F. J. Galindo-Rosales, “Complex Fluids in Energy Dissipating Systems,” *Appl. Sci.*, Vol. 6, No. 8, pp. 206, 2016, DOI: 10.3390/app 6080206.

[2] D. R. Foss and J. F. Brady, “Structure, Diffusion and Rheology of Brownian Suspensions by Stokesian Dynamics Simulation,” *J. Fluid Mech.*, Vol. 407, pp. 167-200, 2000, DOI: 10.1017/S002211 2099007557.

[3] I. R. Peters, S. Majumdar and H. M. Jaeger, “Direct Observation of Dynamic Shear Jamming in Dense Suspensions,” *Nature*, Vol. 532, No. 7598, pp. 214-217, 2016, DOI: 10.1038/nature17167.

[4] B. H. Shen, G. M. Veith, B. L. Armstrong, W. E. Tenhaeff and R. L. Sacci, “Predictive Design of Shear-Thickening Electrolytes for Safety Considerations,” *J. Electrochem. Soc.*, Vol. 164, No. 12, pp. A2547-A2551, 2017, DOI: 10.1149/2.1171712jes.

[5] I. N. Yoon, H. K. Song, J. Won and Y. S. Kang, “Shape Dependence of Sio2 Nanomaterials in a Quasi-Solid Electrolyte for Application in Dye-Sensitized Solar Cells,” *J. Phys. Chem. C*, Vol. 118, No. 8, pp. 3918-3924, 2014, DOI: 10.1021/jp4104454.

[6] S. Merino, C. Martin, K. Kostarelos, M. Prato and E. Vazquez, “Nanocomposite Hydrogels: 3D Polymer-Nanoparticle Synergies for On-Demand Drug Delivery,” *ACS Nano*, Vol. 9, pp. 4686-4697, 2015, DOI: 10.1021/acsnano.5b01433.

[7] D. Schmaljohann, “Thermo- and pH-Responsive Polymers in Drug Delivery,” *Adv. Drug Delivery Rev.*, Vol. 58, pp. 1655-1670, 2006, DOI: 10.1016/j.addr.2006.09.020.

[8] A. R. Maity, A. Saha, A. Roy and N. R. Jana, “Folic Acid Functionalized Nanoprobes for Fluorescence-, Dark-Field-, and Dual-Imaging-Based Selective Detection of Cancer Cells and Tissue,” *Chem Plus Chem*, Vol. 78, pp. 259-267, 2013, DOI: 10.1002/cplu. 201200296.