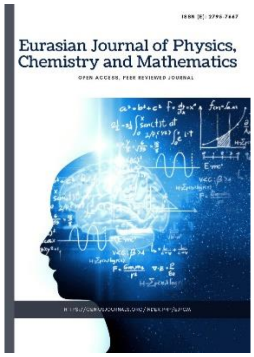


The effect of changing the nano size on the absorption coefficient and the energy gap of crushed Na Cl samples

[1]Mahmoud Hassan Osman Fadl	[1,2]Department of physics, Faculty of Science, Sudan University of Science and Technology, Khartoum, Sudan.
,[2]Mubarak Dirar Abd-Alla	[1,2]Department of physics, Faculty of Science, Sudan University of Science and Technology, Khartoum, Sudan.
[3]Fatma Osman Mahmoud Mohamed	[3] Department of Physics, Faculty of Science, University of Ka ssala, Sudan.
,[4] Faiz M. B. Elshafia	[4] Department of Physics, Faculty of Science & Arts, Qilwah, Al-Baha University, Kingdom of Saudi Arabia, PO Box 1988, Al-Baha. , Saudi Arabia
[5]HassabAlla M.A.Mahmoud	[5] Department of Physics, Faculty of Sciences and Arts Dhahran Al Janoub, King Khalid University, PO Box 9004,Abha, Saudi Arabia

ABSTRACT

Nanoscience represents one of the most powerful tools for controlling and changing the physical properties of matter. In this work, eight NaCl samples were prepared and crushed into different micro sizes. Their nano sizes were examined using an X-ray diffraction technique. The examination showed that the nana crystal size increases upon increasing the micro crunch size. The ultra violet-visible spectrometer results indicate that the absorption coefficient increases and the energy gap decreases when the crystal nano size and the crush size increase .

Keywords: Energy Gap, NaCl

Introduction

Electromagnetic waves play an important role in our life. They are widely used in telecommunications and internet networks. Electromagnetic waves are widely used in a wide variety of applications in medicine and industry. This requires studying their physical properties and their interactions with matter. These include the phenomena of absorption, reflection, and transmission that takes place for the passage of light through a transparent medium [1,2,3].

Light that is transmitted into the transparent materials experiences a decrease in velocity, and, as a result, is bent at the interface; this phenomenon is termed refraction [4,5,6].

When light radiation passes from one medium into another having a different index of refraction, some of the light is scattered at the interface between the two media, even if both are transparent [7,8,9].

The scattering process takes place when the incident electromagnetic beam enters bulk matter. In this case, photons collide with atoms and change their direction and energy. The scattering process leads to energy gain by the medium. This energy can be converted into heat energy or can excite atoms [10,11,12].The control of these physical properties is very difficult within the framework of conventional technology. But unfortunately the so called nano technology opens a new horizon in controlling easily the physical properties of matter. Nano materials are materials in the form of very small, tiny isolated particles having dimensions in the range of a nanometer up to 300 nanometers. These particles obey quantum laws, and their physical properties can be changed easily by changing their nano shape, size structure, and concentration.

As the size of a material reduces to nanometer-scale dimensions, the material in general becomes superior to its bulk counterpart for many applications owing to its higher surface-to-volume ratio, size-dependent properties, and its potential for downscaling of device size [13,14,15].

Among different elements, carbon, placed in group 14 (IV A), has become one of the most important elements in the periodic table owing to its ability to form sp3, sp2, and sp hybrids, which result in 3D (diamond and graphite), 2D (graphene), 1D [carbon nanotube (CNT)], and 0D Fullerene) materials with a wide variety of physical and chemical properties [16,17].

Nanotechnology is the creation of materials and devices by controlling matter at the levels of atoms, molecules, and super-molecular structures. .which means that it is the use of very small particles of materials to create new large-scale materials [18,19,20].This work is devoted to seeing how the change of the nano size changes the absorption coefficient and the optical energy gap. This is done in Section 2. Sections 3 and 4 are concerned with discussion and conclusion.

Optical results of sodium chloride at different sizes of samples

The data of X-ray diffraction (XRD) have been analyzed by to gated crystal structure and lattice parameters of samples, the FT-IR data have been carried to investigate the chemical bonds within atoms, and the data of UV-visible used to evaluate the optical parameters. At last, optical results are calculated.

XRD Results of Sodium Chloride (NaCl) crushed at different size

The result shows the XRD of ten samples of sodium chloride crushed at different sizes.

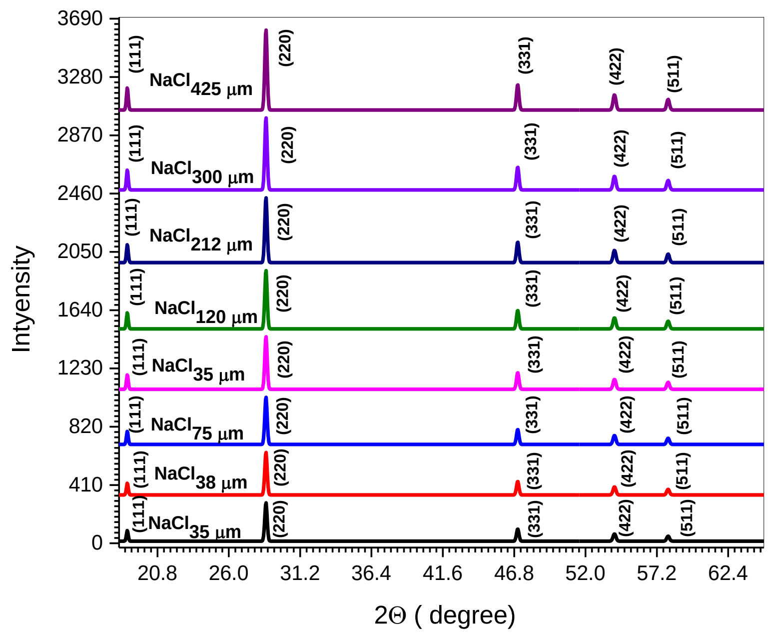


Fig (1) XRD spectrum of sodium chloridecrushed at different size

Table (1) Lattice parameters of sodium chloridecrushed at different size

XRD Data		S1	S2	S3	S4	S5	S6	S7	S8
Space Group		Fm - 3m (225)	Fm - 3m (225)	Fm - 3m (225)	Fm - 3m (225)	Fm - 3m (225)	Fm - 3m (225)	Fm - 3m (225)	Fm - 3m (225)
Crystal System		cubic	cubic	Cubic	cubic	cubic	cubic	cubic	cubic
Cell Parameters 10^{-10} m	a	8.287	8.287	8.287	8.287	8.287	8.287	8.287	8.287
	b	8.287	8.287	8.287	8.287	8.287	8.287	8.287	8.287
	c	8.287	8.287	8.287	8.287	8.287	8.287	8.287	8.287
Density (g.cm^{-3})		3.42	3.31	3.24	3.11	2.96	2.81	2.79	2.73
Volume $(10^{-10})^3$		569.1	569.4	569.7	569.9	570.1	570.3	570.6	570.9
d (10^{-10} m)		2.58	2.62	2.68	2.73	2.79	2.84	2.88	2.93
Cell Angular	alpha	90	90	90	90	90	90	90	90
	beta	90	90	90	90	90	90	90	90
	gamma	90	90	90	90	90	90	90	90

FTIR Results of Sodium Chloride (NaCl) at different size

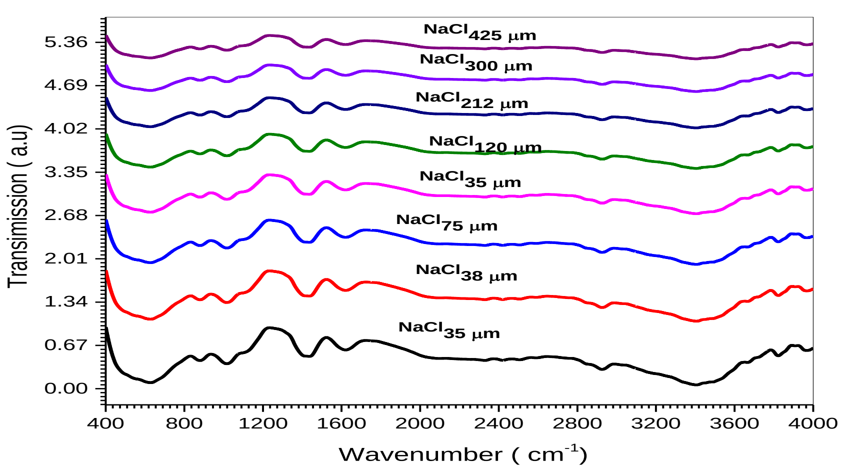


Fig (2) IR spectrum of sodium chloride crushed at different size

Table (2) Table of Characteristic IR sodium chloride crushed at different size samples

No	Wavenumber (cm^{-1})	Functional Group Names	Type of Vibration
1	615	alkyl halides	C–Br stretch
2	890	aromatics	C–H "oop"
3	1112	aliphatic amines	C–N stretch
4	1426	aromatics	C–C stretch (in–ring)
5	1377	alkanes	C–H rock
6	1620	1° amines	N–H bend
7	2325	nitriles	C≡N stretch
8	2415	thiol	S-H (very weak)
9	2510	carboxylic acids	O–H stretch
10	2925	alkanes	C–H stretch
11	3400	alcohols, phenols	O–H stretch, H–bonded
12	3830	water	O–H stretch, free hydroxyl
13	3960	water	O–H stretch, free hydroxyl

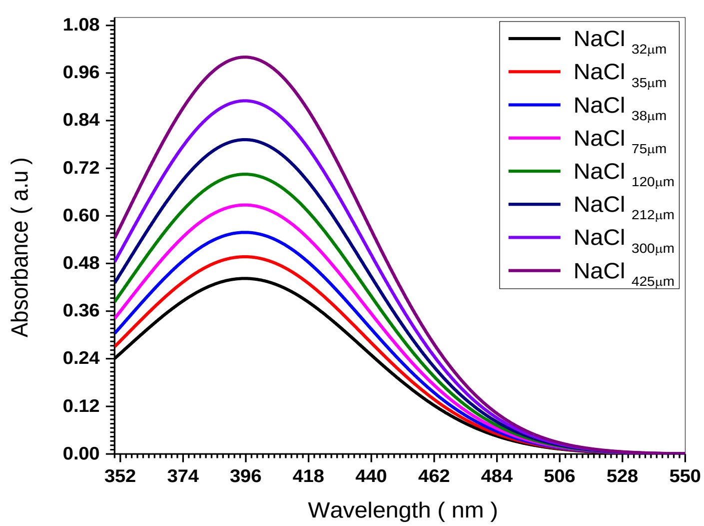


Figure (3) absorbance spectra of sodium chloride crushed at different size samples

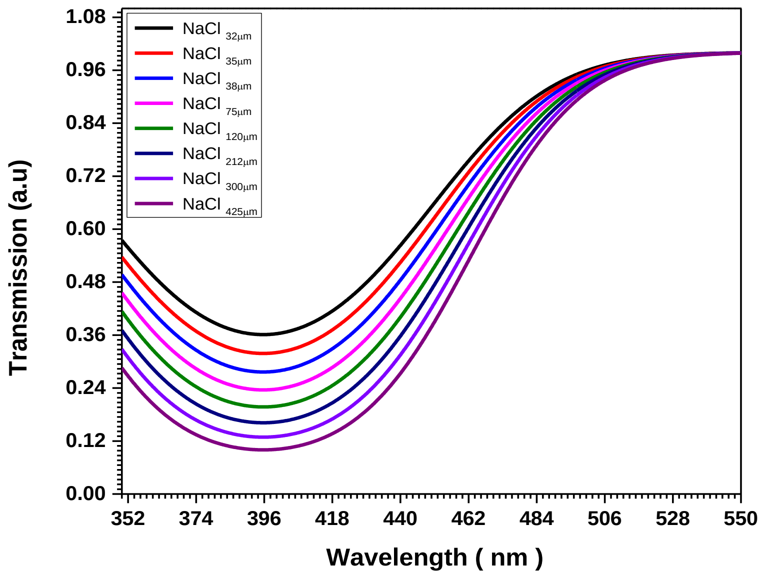


Figure (3) Transmission spectra of sodium chloride crushed at different size samples

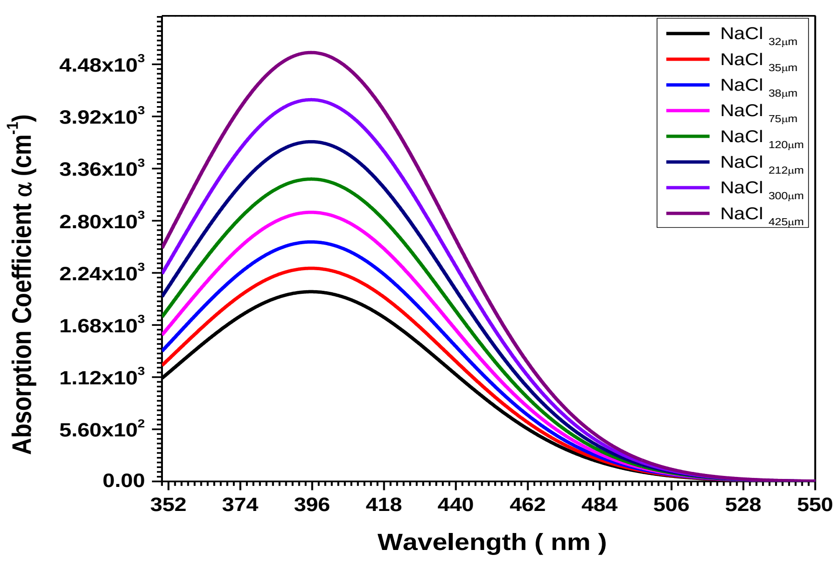


Figure (4) Absorption coefficient of sodium chloride crushed at different size samples as a function in wavelength

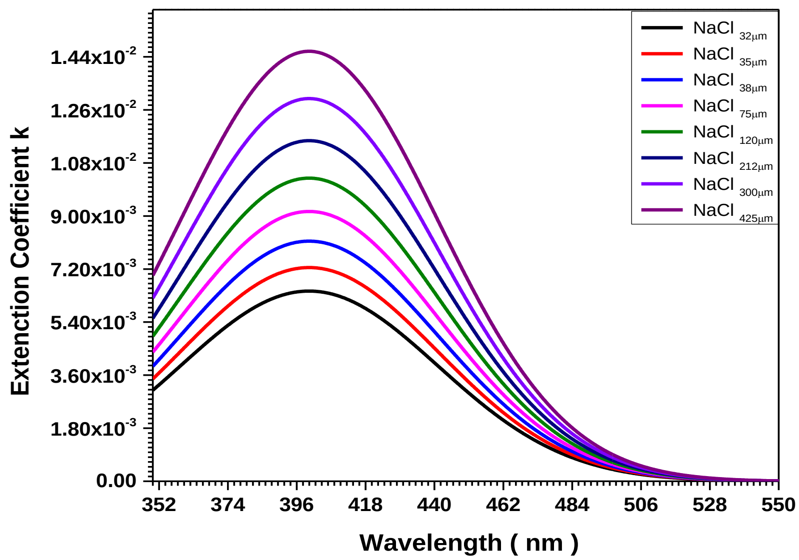


Figure (5) Extinction coefficient of sodium chloride crushed at different size samples as a function in wavelength

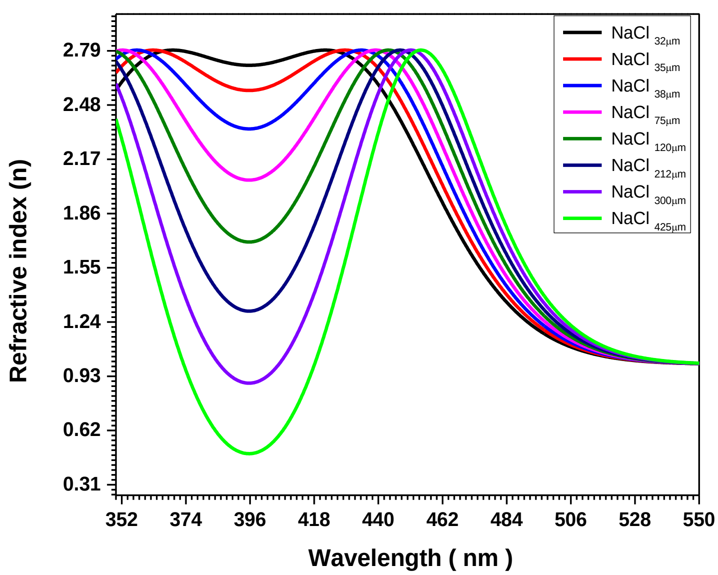
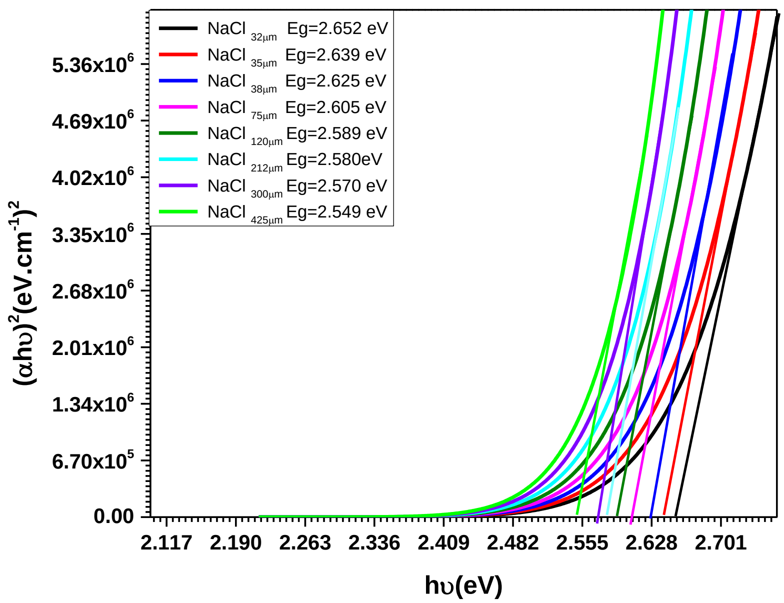


Figure (6) Refractive index of sodium chloride crushed at different size samples as a function in wavelength



Fig(7) optical energy band gap ofsodium chloride crushed at different size samples

Effect of Crushed Size on Properties of SodiumChloride Samples

Table (3)Structurer, optical, electrical and magnetic properties of sodium chloride crushed at different size samples (all properties studied at wavelength 395 nm).

Sample	d-space 10^{-10}m	Density mg.cm^{-3}	Volume $(10^{-10}m)^3$	Eg eV	Refractive Index
$NaCl_{32\mu m}$	2.58	3.42	569.1	2.652	2.71
$NaCl_{35\mu m}$	2.62	3.31	569.4	2.639	2.56
$NaCl_{38\mu m}$	2.68	3.24	569.7	2.625	2.35
$NaCl_{75\mu m}$	2.73	3.11	569.9	2.605	2.05
$NaCl_{120\mu m}$	2.79	2.69	570.1	2.589	1.70
$NaCl_{212\mu m}$	2.84	2.81	570.3	2.580	1.30
$NaCl_{300\mu m}$	2.88	2.79	570.6	2.570	0.89
$NaCl_{425\mu m}$	2.93	2.73	570.9	2.549	0.48

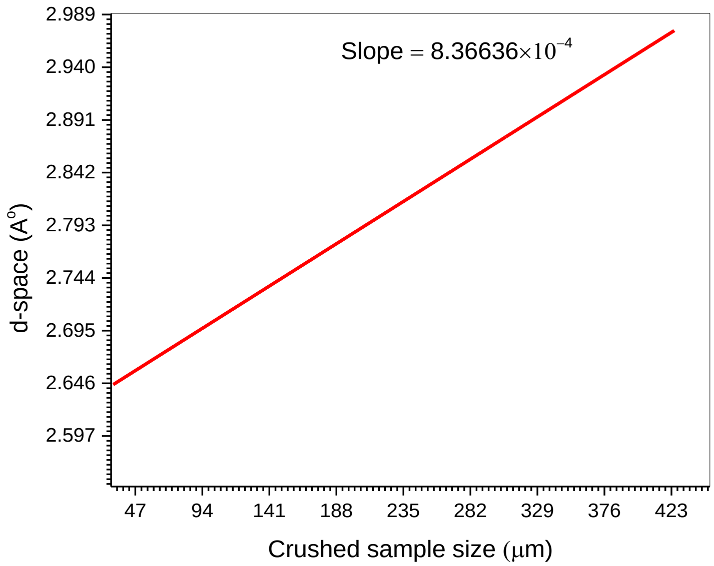


Figure (8) Relationship between crushedsize of sodium chloride samplesand d-space

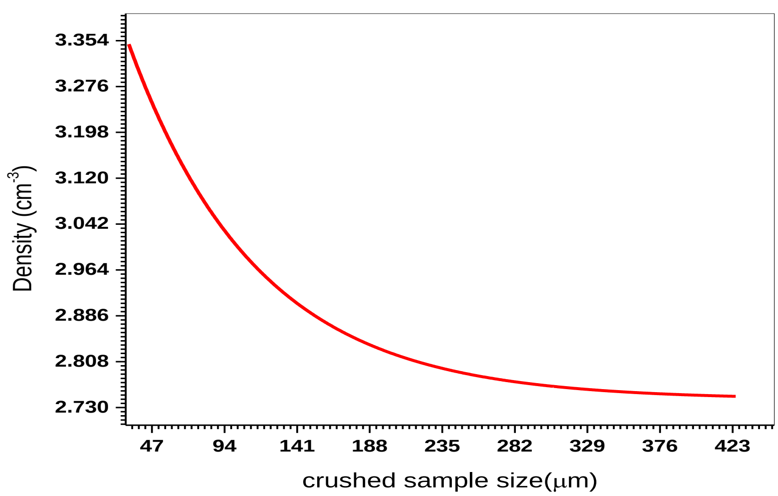


Figure (9) Relationship between crushedsize of sodium chloride samplesand density

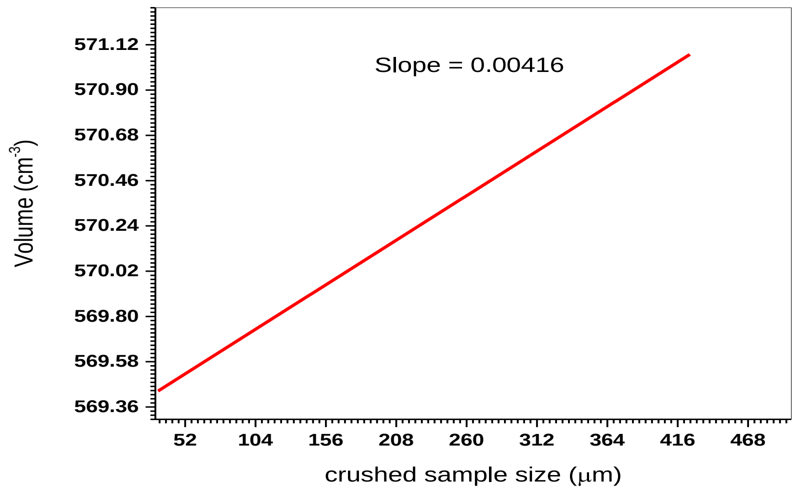


Figure (10) Relationship between crushedsize of sodium chloride samplesand volume

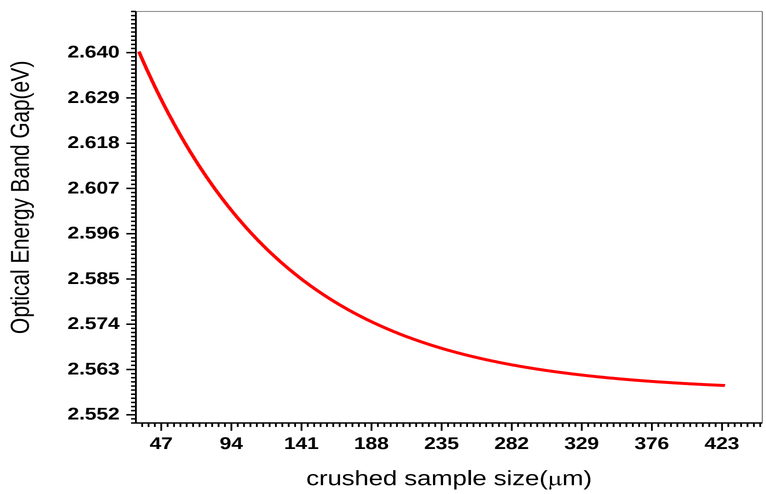


Figure (11) Relationship between crushedsize of sodium chloride samplesand optical energy band gap

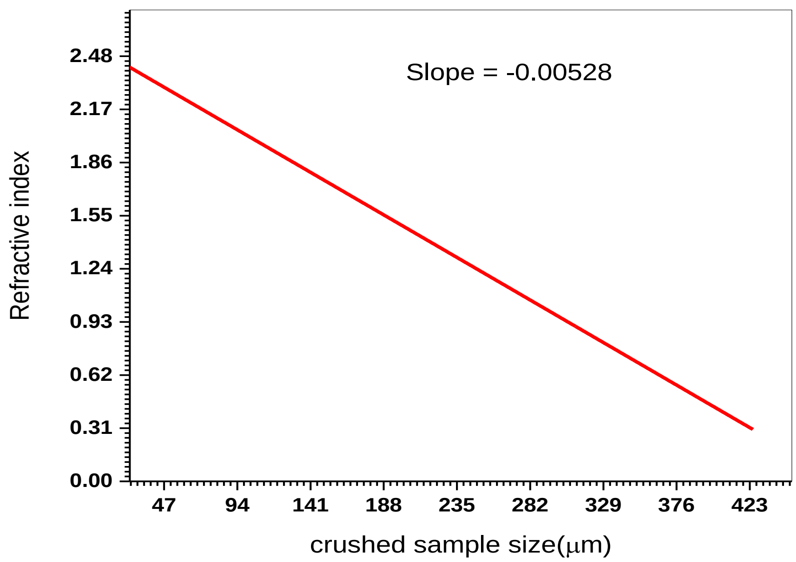


Figure (12) Relationship between crushedsize of sodium chloride samplesand refractive index

Discussion

The change of some optical and electrical properties of the 8 samples of NaCl when crushed shows very interesting properties. Using a UV spectrometer, the change of absorption coefficient , refractive index, and energy gap were displayed graphically against the wavelength for different Nacl crushed sizes (32, 25, 28, 75, 120, 212, 300, and 425m). The absorption coefficient decreases when the nano and crush sizes decrease, as shown in figure (3). The refractive index in figures (6,12) decreases upon increasing the crush size in the wave length range (352 – 462 nm), after that it increases.

The energy gaps decrease upon increasing the crush size as shown in the figures (7,11). Both crystal spacing and nanocrystal volume increase upon increasing the crush size as shown in figures (8 and 10). However, the density decreases upon increasing crush size as shown in figure (9).

Conclusion:

The crushing of NaCl into small particles having different micro sizes shows that this causes their nano size to increase upon increasing their micro size, where each micro particle consists of aggregates of nano crystals. The absorption coefficient, crystal spacing increase upon increasing the nano and micro size. The energy gap decreases upon increasing the nano and micro sizes.

References

1. R. Serway, (1996) physics, Saunders, collegecompany, U.S.A.
2. partha.p. Banerejee, Tung-ching poon, principle of applied optics. Library of congress cataloging .USA (1991).
3. Peter J. Nolan (2014),Fundamentals oF modern Physics ,First edition, United States of America, ISBN-13: 978-0-7167-7550-8.
4. Gerry C, Knight P, Introductory Quantum Optics, Cambridge

University Press, Cambridge, 2005. And also to see the criteria of coherent state of the light see: Walls DF, Millburn GJ, Quantum Optics. Springer-Verlag New York, 1995.
5. Abdulaziz, Qassim MJ, and A. Al Naimee. "Attractor selection in semicond optoelectronic feedback." Australian Journal of Basic and Applied Sciences 10.13 (2016)
6. Mahmoud, H. M., & Abdalgadir, L. M. (2021). Relativistic Quantum Equation For Electromagnetic Field And Bio Photons. NVEO-NATURAL VOLATILES & ESSENTIAL OILS Journal| NVEO, 3020-3030.
7. Rajesh, S., and V. M. Nandakumaran. "Control of bistability in a directly modulated semiconductor laser using delayed optoelectronic feedback." Physica D: Nonlinear Phenomena 213.1 (2006).
8. Mohammed, E. A. E., Mahmoud, H. M., Abdalgadir, L. M., Alshekh, M. A., & Bush, H. S. (2022). Material properties for absorption, lasing, micro capacitors and inductors using Maxwell's equations. Materials Today: Proceedings.
9. Weingartner, E., et al. "Absorption of light by soot particles: determination of the absorption coefficient by means of aethalometers." Journal of Aerosol Science 34.10 (2003).
10. Mahmoud, H. A. M., Abdalgadir, L. M., Rashed, M. M., Widaa, E. M. A., & Alshekh, M. A. (2022). Energy Conservation for Fluids and Radiation Beams Using Pressure Notion to Account for Thermal, Mechanical, and Frictional Collisional Energy. NeuroQuantology, 20(4), 389-392.
11. Smedley, J., et al. "Electron amplification in diamond." AIP Conference Proceedings. Vol. 877. No. 1. American Institute of Physics, 2006.
12. Elammeen, G. E., Musa, A. E., Mahmoud, H. M., Mohammed, E. E., Abdallah, M. D., & Ahmed, S. A. E. The Wave Function and the Energy of Crystalline Regular Nano Particles in A uniform Crystal Field for Spherically Symmetric System According to Sting Theory.
13. Musa, A. E., Elammeen, G. E., Mahmoud, H. M., Mohammed, E. E., Abdallah, M. D., & Ahmed, S. A. E. Energy Quantization of Electrons for Spherically Symmetric Atoms and Nano Particles According to Schrödinger Equation.
14. Gramsch, Ernesto, et al. "Use of the light absorption coefficient to monitor elemental carbon and PM2. 5—example of Santiago de Chile." Journal of the Air & Waste Management Association 54.7 (2004).
15. Dall'Olmo, Giorgio, et al. "Determination of the absorption coefficient of chromophoric dissolved organic matter from underway spectrophotometry." Optics express 25.24 (2017).
16. Weingartner, E., et al. "Absorption of light by soot particles: determination of the absorption coefficient by means of aethalometers." Journal of Aerosol Science 34.10 (2003).
17. Abdulaziz, Qassim MJ, and A. Al Naimee. "Attractor selection in semicond optoelectronic feedback." Australian Journal of Basic and Applied Sciences 10.13 (2016)

18. Rajesh, S., and V. M. Nandakumaran. "Control of bistability in a directly modulated semiconductor laser using delayed optoelectronic feedback." Physica D: Nonlinear Phenomena 213.1 (2006).
19. Li, B., Wang, L., Kang, B., and Qiu, Y., Solar Energy Materials and Solar Cells, Wiley-VCH, (2006)
20. Nanotechnology-2nd Edition, www.elsevier.com.Retrieved (2021)