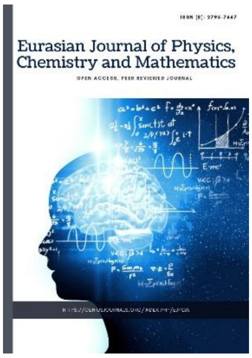

The Effect of Changing the Nano and Micro Size of NaCl Crystal on its Conductivity, Electric Permittivity, and Magnetic Permeability

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ABSTRACT

The electric and magnetic properties of matter play an important role in the fabrication of electronic chips. This encourages us to do this work. In this work, eight NaCl samples were prepared and crushed into different micro and nano sizes. Their nano sizes were examined using an X-ray diffraction technique, and their electrical and magnetic properties were examined using a visible and ultra violet spectrometer. The results obtained indicate that the electric conductivity, electric permittivity, and magnic permeability decrease for short wavelengths and increase for long wave lengths upon increasing the crush and nano sizes.

Keywords:

Introduction

The physical properties of matter plays an important role in our day life. These properties are used widely in industry to fabricate machines and electronic devices. This include mechanical, thermal, electric, and magnetic properties. These properties are widely used in industry for fabrication of electronic devices like mobile phones, computers, and solar cells [1,2,3]. The magnetic properties are mainly used in generating electric power and for fast trains. The mechanical properties are used for fabricating light and strong body forcars, and thermally isolated strong materials buildings [4,5,6]. The control and change of material properties to satisfy the rapid needs of industry is the main goal of modern science and technology.

The discovery of new materials with unique properties is the principal parameter for the sustained development of contemporary devices and for up liftmen of device performances. In the last decade, intensive research efforts were made to create a large number of novel materials, notably those belongs to the nano technology [7,8] .

Nano technology is a new branch of physics that emerges as a direct application of nano science. Nano science is the branch of physics that is concerned with the materials that are in the form of isolated particles having dimensions in the range of a nanometer up to 300 nano meters. The behavior of such nano isolated particles obeys quantum laws[9,10,11]. The fundamental absorption is related to band-to-band or to exaction transition, which are subjected to certain selection rules [12,13]. The transitions are classified into several types, according to the band structure of a material

Absorption takes place when photons are incident on atoms to remove electrons from the ground state to one of excited state

Nanometers are formed from Nano isolated particles which does not interact with each other [14,15]. This means that Nano materials have different physical properties from the bulk matter these properties include optical, mechanical, electrical, magnetic and thermal properties [16,17].The new properties of Nano materials open a new horizon in technology[18,19]. It enables scientists to control some physics.The aim of this work is to study the effect of changing nano size on the conductivity, electrical permittivity and magnetic permeability [20,21]. This is done in section 2.sections 3 and are concerned with discussion and conclusion

Materials and method:

Row sodium chloride (Nacl) was crushed then the powder passed through different milles having different micro sizes, crystal and nanostructures of the samples where characterized by X-ray diffraction (XRD) while the optical properties like absorption and energy gap were determined by using UV-visible absorption spectrophotometer , X-ray diffraction is a technique to study crystal structures like atomic spacing and the distance between crystal planes beside the nano crystal size. The X-ray diffract meters consists of three basic elements: x –ray tube, a sample holder, and x- ray detector. Ultraviolet and Visible Spectrometer is an absorption spectroscopy using electromagnetic radiations having wave length in the rage between 190 nm to 800 nm and is divided into the ultraviolet (UV, 190-400 nm) and visible (VIS, 400-800 nm) regions.

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

The result blow shows the XRD of ten samples for sodium chloride crushed at different size

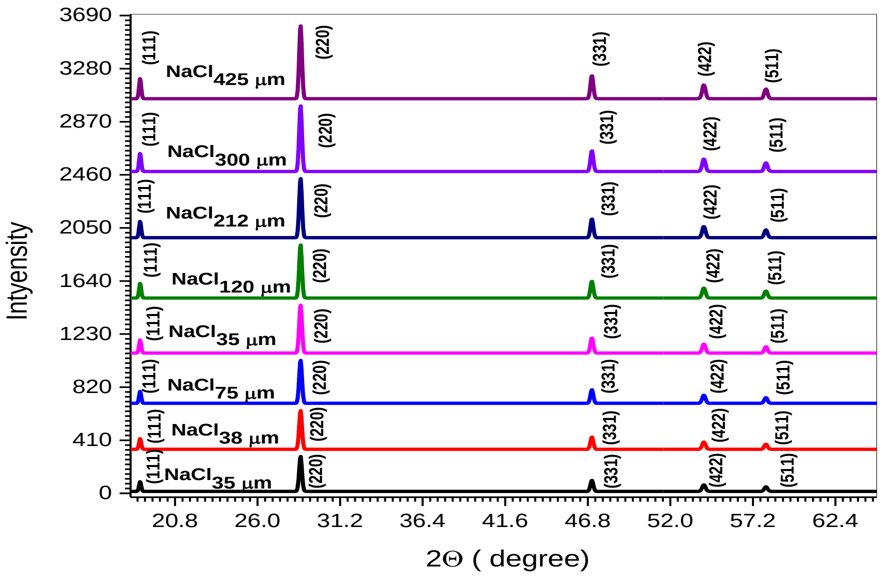


Fig (1) XRD spectrum of sodium

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

After constructed eight Sodium Chloride (NaCl) crushed at different size samples, Fourier transforms infrared spectroscopy (FTIR) to study the vibrational frequencies.

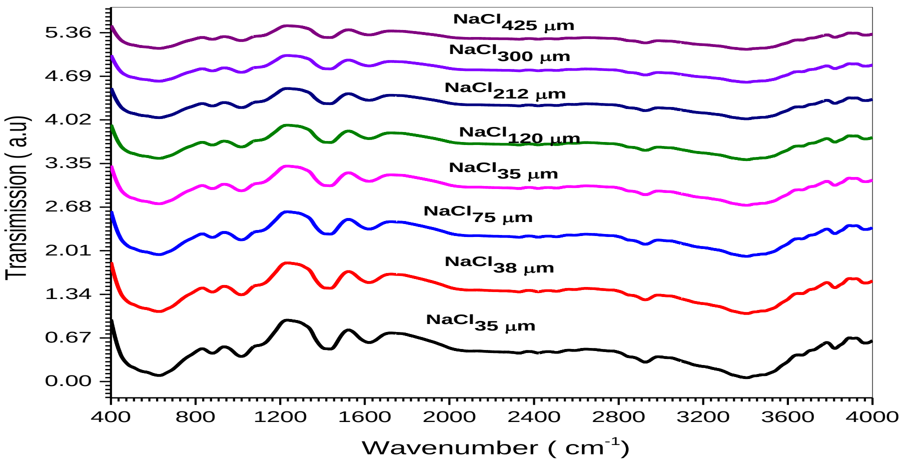
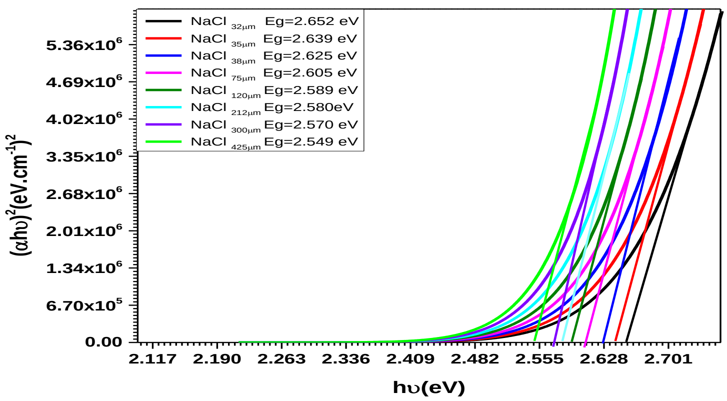


Fig (2) IR spectrum of sodium chloride crushed at different size

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



Fig(3) optical energy band gap ofsodium chloride crushed at different size samples

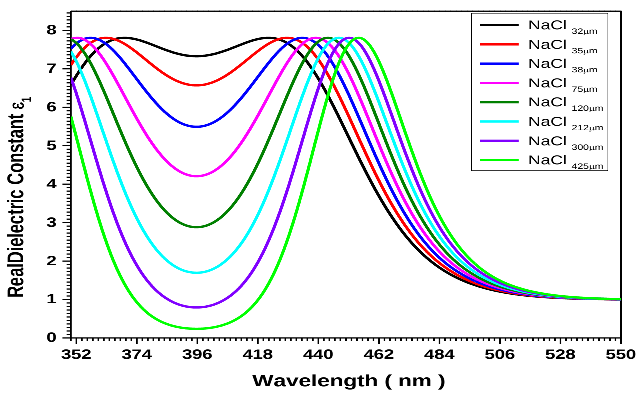


Figure (4) Real dielectric constant of sodium chloride crushed at different size samples as a function in wavelength

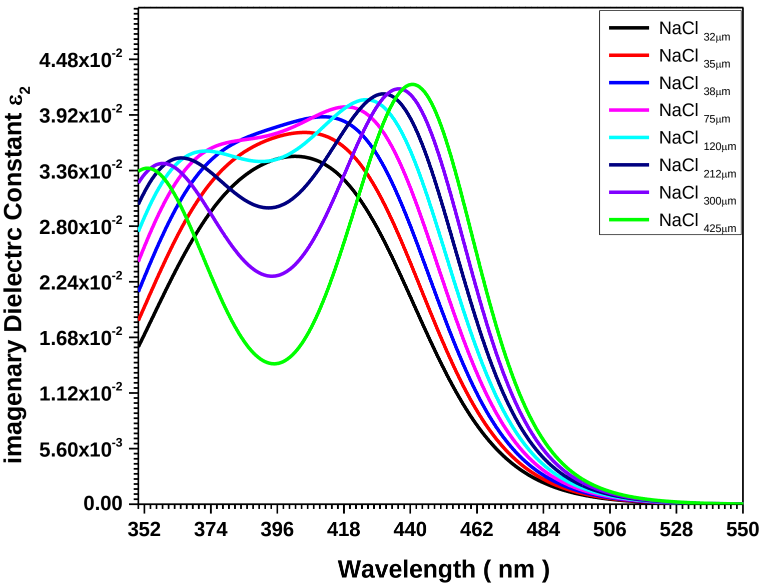


Figure (5) Imaginary dielectric constant of sodium chloride crushed at different size samples as a function in wavelength

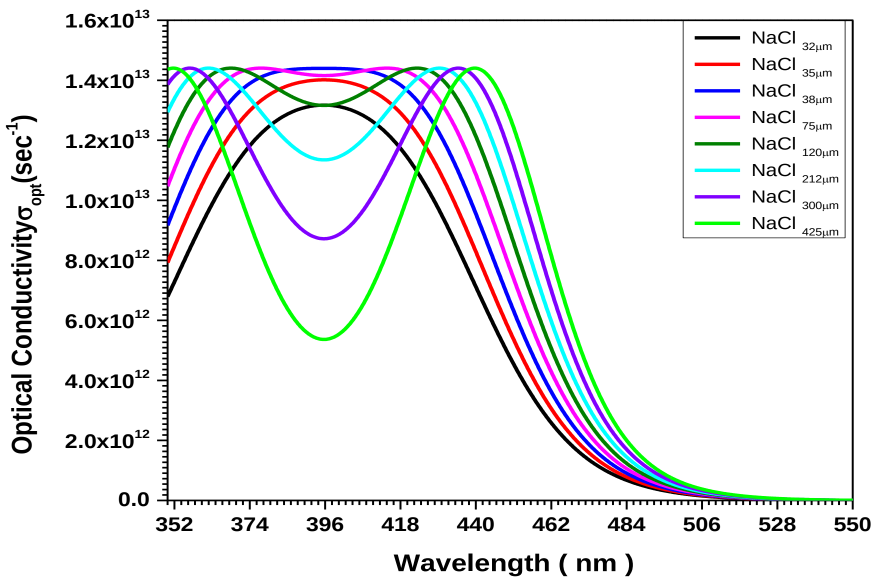


Figure (6) Optical conductivity of sodium chloride crushed at different size samples as a function in wavelength

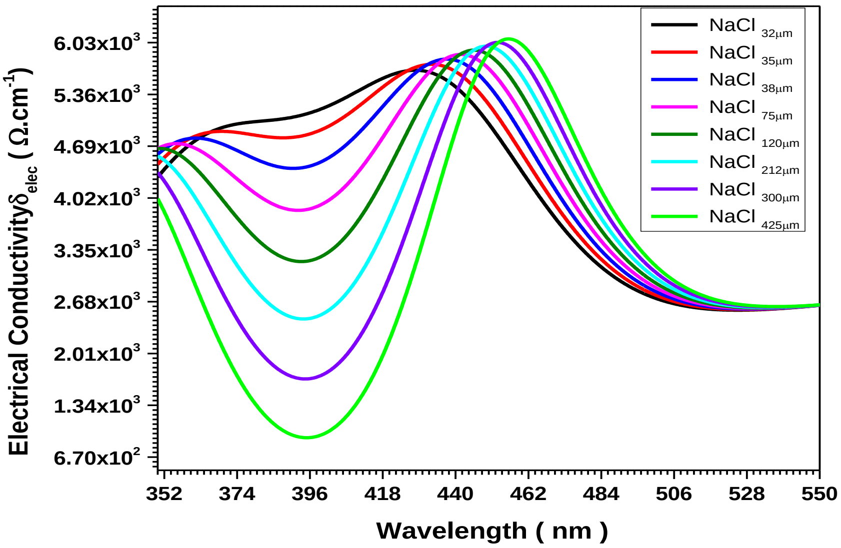


Figure (7) Electrical conductivity of sodium chloride crushed at different size samples as a function in wavelength

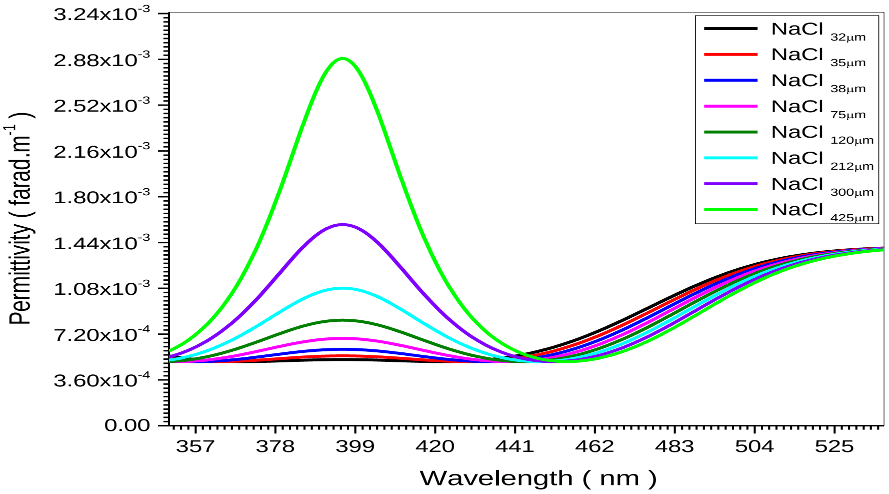


Figure (8) Magmatic permittivity of sodium chloride crushed at different size samples as a function in wavelength

Effect of Crushed Size on Properties of SodiumChloride Samples

Table (3)Structure, 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	Electrical Conductivity $\times 10^3 (\Omega.m)^{-1}$	electrical permeability (μ) (10^{-8} henry/m)	magmaticpermittivity (ε_r) (10^{-3} farad/m)
NaCl	2.58	3.42	569.1	2.652	5.12	1.70	0.53

32µm							
NaCl 35µm	2.62	3.31	569.4	2.639	4.84	1.60	0.55
NaCl 38µm	2.68	3.24	569.7	2.625	4.41	1.50	0.61
NaCl 75µm	2.73	3.11	569.9	2.605	3.88	1.30	0.69
NaCl 120µm	2.79	2.69	570.1	2.589	3.19	1.10	0.84
NaCl 212µm	2.84	2.81	570.3	2.580	2.45	0.80	1.09
NaCl 300µm	2.88	2.79	570.6	2.570	1.69	0.50	1.59
NaCl 425µm	2.93	2.73	570.9	2.549	0.89	0.30	2.90

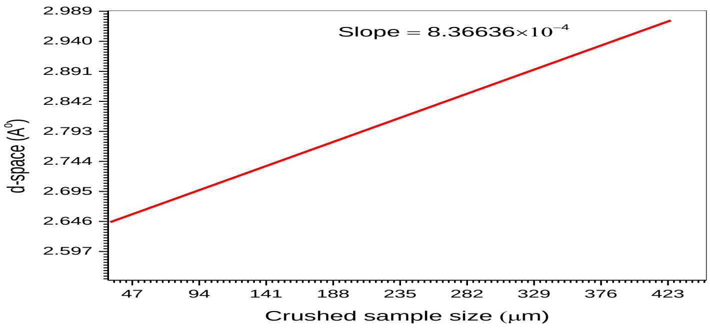


Figure (9) Relationship between crushedsize of sodium chloride samplesand d-space

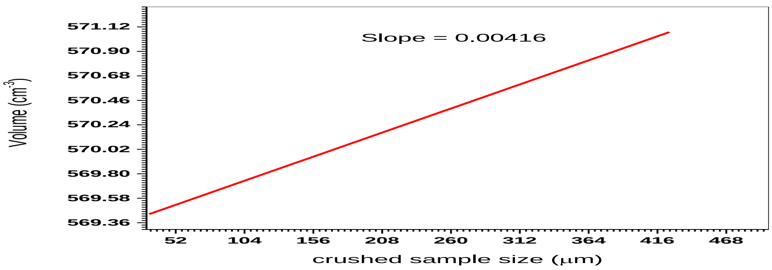


Figure (10) Relationship between crushedsize of sodium chloride samplesand density

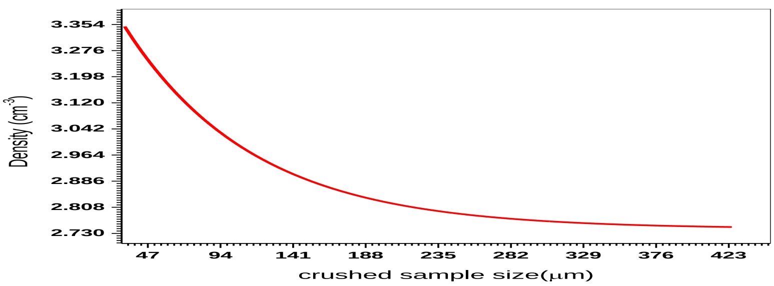


Figure (11) Relationship between crushedsize of sodium chloride samplesand volume

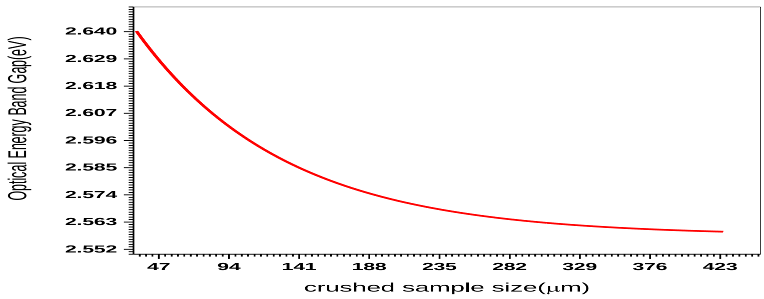


Figure (12) Relationship between crushedsize of sodium chloride samplesand optical energy band gap

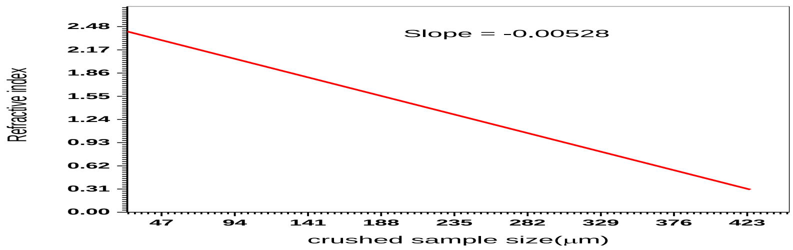


Figure (13) Relationship between crushedsize of sodium chloride samplesand refractive index

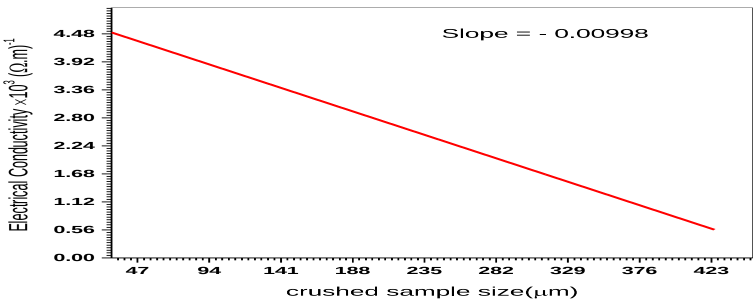


Figure (14) Relationship between crushedsize of sodium chloride samplesand electrical conductivity

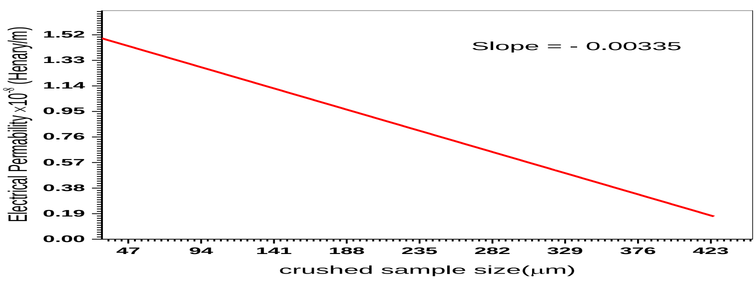


Figure (15) Relationship between crushedsize of sodium chloride samplesand electrical permeability

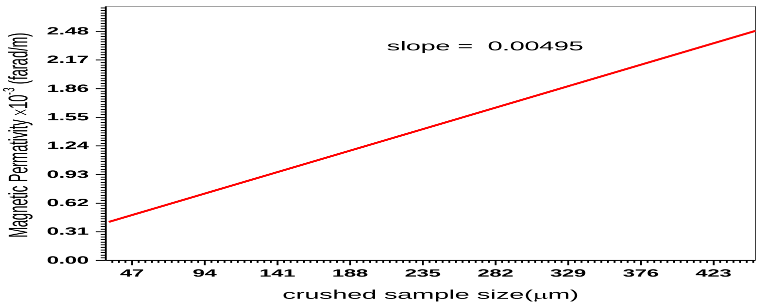


Figure (16) Relationship between crushedsize of sodium chloride samplesand magnetic permittivity

Discussion

According to figure (4) the electric permittivity decreases upon increasing the crush and nano sizes for short wavelengths in the range (360-460 nm) then it increases after that for all long wave lengths in the studied range. Figures (6,7) for the optical and electrical conductivity indicated also that they decrease upon increasing the crush and nano sizes in the same wavelength range, then increased for longer wavelengths also. This may be related to the fact that the increase of the crush and nano sizes decreases the number of the free electrons which increases upon decreasing the nano and micro size. These small sizes produce small crystal fields thus increased the ability of the electrons to scape and become free.

Figures (8,16) showed that the magnetic permeability decreases upon increasing crush size in the range 360 – 462nm, while it increases with the crush size for wave lengths more than 462nm However the density decreases upon increasing crush size.

Conclusion

The electric, optical conductivites, beside the electric permittivity and magnetic permeability decreases upon increasing the crush and nano sizes for short wavelengths in the range of (360-460 nm), then they increase after that for longer wavelengths.

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