Afaq Journal for Human and Applied Studies
Faculty of Arts and Sciences
ALAbyar University of Benghazi
ISSUE: 2 – August 2024

مجلة آفاق للدراسات الإنسانية والتطبيقية
كلية الآداب والعلوم الإبيار
جامعة بنغازي
العدد: الثاني - أغسطس 2024

# Influence of annealing on Si-Ge thin films with high concentration of tellurium and zinc

[1]Dr.Ibrahim A. Saleh.

1. Assistant Professor of Physics Department, Faculty of Arts and Science"Al Abyar",Benghazi University,Abraheem.salih@uob.edu.ly.

| DOI: https://doi.org/10.37376/ajhas.vi2.6862 | Received: 11.05.2024 | Accepted: 20.05.2024 | Published: 16.08.2024 |
|---|---|---|---|

**Abstract:**

The elements are distinguished via the basis of energy band gap. Two configurations $Si_{10}Ge_{10}Te_{80}$ and $Si_{10}Ge_{10}Zn_{80}$ multilayers were annealed under vacuum at eutectic temperature of 400 °C to form alloys between the deposited layers. The two samples were studied at different temperatures to improve the physical properties of the thin films. Kinetics of the two configurations $Si_{10}Ge_{10}Te_{80}$ and $Si_{10}Ge_{10}Zn_{80}$ were studied in the temperature range 308- 673 °K. The results revealed that the crystallization of the thin film of multilayer for the samples increases with increasing the annealing temperature and increasing the zinc content. The influence of annealing on the structure and stability of the samples has been studied by X- ray diffraction. The optical and electrical measurements were carried out after annealing. The electrical conductivity of the two samples was measured as a function of temperature and annealing time. It was found that the electrical conductivity for $Si_{10}Ge_{10}Zn_{80}$ increases, and the optical gap decrease due to the crystallization effects that occurs only in Ge matrix and with increasing zinc content at high concentration.

**Keywords:** thin films, annealing, temperature, crystallization, optical gap, electrical conductivity.

Afaq Journal for Human and Applied Studies
Faculty of Arts and Sciences
ALAbyar University of Benghazi
ISSUE: 2 – August 2024

مجلة آفاق للدراسات الإنسانية والتطبيقية
كلية الآداب والعلوم الإبيار
جامعة بنغازي
العدد: الثاني – أغسطس 2024

# تأثير التلدين على أغشية (Si-Ge) الرقيقة ذات التركيز العالي من التيلوريوم والزنك

د. إبراهيم صالح عبد الحفيظ.[1]

1. أستاذ مساعد بقسم الفيزياء، كلية الآداب والعلوم "الأبيار"، جامعة بنغازي.

## الملخص

يتم تمييز العناصر من خلال فجوة نطاق الطاقة الأساسية. تم التلدين بتكوينين Si10Ge10Te80 و Si10Ge10Zn80 متعدد الطبقات تحت فراغ عند درجة حرارة سهلة الانصهار تبلغ 400 درجة مئوية لتشكيل سبائك بين الطبقات المودعة. تمت دراسة العينتين عند درجات حرارة مختلفة لتحسين الخواص الفيزيائية للأغشية الرقيقة. تمت دراسة حركية التكوينين Si10Ge10Te80 و Si10Ge10Zn80 في المدى الحراري 308-673 درجة مئوية. أظهرت النتائج أن تبلور الطبقات الرقيقة للعينات يزداد مع زيادة درجة حرارة التلدين وزيادة محتوى الزنك. تمت دراسة تأثير التلدين على بنية وثبات العينات باستخدام حيود الأشعة السينية. تم إجراء القياسات الضوئية والكهربائية بعد التلدين. تم قياس التوصيل الكهربائي للعينتين كدالة لدرجة الحرارة وزمن التلدين. وجد أن الموصلية الكهربائية لـ Si10Ge10Zn80 تزداد، وتقل الفجوة الضوئية بسبب تأثيرات التبلور التي تحدث فقط في مصفوفة Ge ومع زيادة محتوى الزنك عند التركيز العالي.

الكلمات المفتاحية: الأغشية الرقيقة، التلدين، درجة الحرارة، التبلور، الفجوة الضوئية، التوصيل الكهربائي.

Scan QR & Read Article Online.

E-ISSN 3007-4495
ISSN-L 3007-4495
Legal Deposit Number 313/2023
DOI https://doi.org/10.37376/ajhas.vi2
Frequency: Two Issues per year
Publication Fees are Free
Publisher: University of Benghazi, Benghazi, Libya
Editor-in-Chief Prof. Mohamed Lama
https://journals.uob.edu.ly/AJHAS
ajhas.journal@uob.edu.ly
+218924809776

Afaq Journal for Human and Applied Studies
Faculty of Arts and Sciences ALAbyar University of Benghazi
ISSUE: 2 – August 2024
مجلة آفاق للدراسات الإنسانية والتطبيقية
كلية الآداب والعلوم الإبيار
جامعة بنغازي
العدد: الثاني – أغسطس 2024

## 1.Introduction

The.modern.technological.era .started.with.the.invention.of.the.trans istor.and.the.birth.of.solid.state.electro nics..From.that.date,.we.have.been.rap idly.developed.the.science.and.techno logy.based.firstly.on.germanium,.then .on.silicon,.and.later.on.multilayers.fo r.elements.with.germanium,.and.silico n.The.necessity.to.save.weight.and.rat io.of.element,.and.to.improve.the.elec trical.conductivity.in.the.function.of.t he.devices,.stimulated.an.intense.rese arch.activity.to.obtain.the.thin.films.fr om.multilayers..In.the.same.time,.the. worldwide.interest.was.moved.from.el ectronic.to.more.complex.optoelectro nic.applications..Taking.into.account.t hese.big.tasks.,.the.class.of.materials. must.be.enlarged,.new.materials.with. new.properties.must.be.prepared..The. physical.properties..of.thin.films.mate rials.of.many.semiconductors.and.ele ments.has.been.investigated.[18]..

The.improvement.of.devices. based.on.the.prepared.materials.via.di fferent.high.technology.fields.of.scien ce..Nowadays,.commercial.devices.re quire.the.development.of.tailored.mat erials..Approaches.to.evaluate.the.phy sical.properties.of.their.structures.pro duces.an.inevitable.industrial.delay.in. the.devices.improvement..Moreover,. with.the.trend.to.continuous.curing.of. the.components.makes.it.becomes.nec essary.to.deal.with.the.spatial.resoluti on.problem..For.the.advance.in.such.a pplications,.the.locally.investigation.o f.the.change.in.the.electrical.conducti vity.with.temperature.and.elements.co ntents.of.in.new.compounds.of.materi als.is.therefore.a.key.issue.

Materials.are.commonly.affecte d.by.a.large.concentration.of.point.defe cts,.hence.the.heat.treatment.are.very.i mportant..The.transition.of..crystalline. state.proceeds..by.nucleation.and.growt h..reactions,.a.systematic.study.on.the.k inetics.of.the.crystal.phase.remains.one .of.the.most.interesting.aspects.of.physi cs.properties.[7]..

A.strict.control.on.the.ratio.of. materials.and.location.is.necessary,.but. also.because.their.behavior.in.the.mater ial.structure.is.still.rather.unclear..Elect rical.conductivity.may.also.be.used.to.i nvestigate.of.crystallization.for.materia l.of.thin.films.and.type.of.elements.[9].

The.aim.of.this.work.is.to.study .the.physical.properties.of.the.thin.film

E-ISSN 3007-4495
ISSN-L 3007-4495
Legal Deposit Number 313/2023
DOI https://doi.org/10.37376/ajhas.vi2
Frequency: Two Issues per year
Publication Fees are Free
Publisher: University of Benghazi, Benghazi, Libya
Editor-in-Chief Prof. Mohamed Lama
https://journals.uob.edu.ly/AJHAS
ajhas.journal@uob.edu.ly
+218924809776

s.for.multilayers.and.using.the.results.to.investigate.affects.on.the.electrical.conductivity.with.annealing,and.high.concentration.of.materials.contents.

**II.Experimental**

Two.configurations.of.multilayers.were.deposited.using.Edwards.306.thermal.evaporator.under.vacuum.of.6×10$^{5}$.mbar.on.borosilicate.glass.substrates..The.first.configuration.consists.of.silicon(Si),.germanium.(Ge),.and.tellurium.(Te),.and.the.second.configuration.consists.of.silicon.(Si),.germanium.(Ge),.and.Zinc.(Zn)..The.Two.samples.prepared.at.80°C...The.first.sample.in.this.configuration.is.$Si_{10}Ge_{10}Te_{80}$.and.the.thicknesses.of.layers.of.this.sample.are.30.nm.of.Si,.30.nm.of.Ge,.and.240.nm.of.Te..The.second.sample.in.this.configuration.is.$Si_{10}Ge_{10}Zn_{80}$.and.the.thicknesses.of.layers.of.this.sample.are.30.nm.of.Si,.30.nm.of.Ge,.and.240.nm.of.Zn..The.samples.of.the.two.configurations.are.then.annealed.under.vacuum.at.eutectic.temperature.of.400.°C.to.form.alloys.between.the.deposited.layers..The.following.table.shows.the.prepared.samples..The.total.film.thickness.measured.by.the.Dectak.surface.profiler.was.in.the.range.of.300nm.

The.crystallinity.of.the.two.samples.was.measured.by.Xray.diffractometer.(.Model:.Labx.XRD6100.).provided.by.copper.(Cu).Xray.tube.of.wavelength.λ=1.54**Å**.was.used.for.structue.analysis.of.the.thin.films**..**The.interplaner.distance.was.determined.using.Bragg`s.Equation:2d.sinθ.=.n.λ

Where.d.is.the.interplaner.distance.and.θ.is.the.angle.of.x-ray.diffraction.

JASCO.V630.UVVIS.Spectrophotometer.was.used.for.transmission.and.absorption..measurements..A.cryostat.(.photon.cryostat.220.Ohmmetry.).was.used.for.electrical.measurements The.sample.is.maintained.between.two.electrodes.as.a.coplanar.structure.attached.to.a.dc.voltage.of.60.Volt..The.pressure.is.about.6×10$^{3}$.mbar,.depending.on.the.geometry.of.the.vacuum.chamber..The.substrate.holder.is.provided.by.heating.system.to.raise.the.temperature.of.the.sample.up.to.60 °C.

Afaq Journal for Human and Applied Studies
Faculty of Arts and Sciences
ALAbyar University of Benghazi
ISSUE: 2 – August 2024
مجلة آفاق للدراسات الإنسانية والتطبيقية
كلية الآداب والعلوم الإبيار
جامعة بنغازي
العدد: الثاني - أغسطس 2024

### III.Results.and.discussion

#### 1.The.Xray.diffraction.(XRD)

The.structural.properties.of.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.prepared.at.80°C.and.annealed .at.400°C.for.have.been.investigated. by.XRD..The.phases.appeared.in.the. xray.spectra.are.GeGe(111),.GeGe(211),.GeGe(220).for.sample.$Si_{10}Ge_{10}Zn_{80}$.and.phases.appeared.in.the.x.ray. spectra.are.GeGe(111),GeGe(211).for.sample.$Si_{10}Ge_{10}Te_{80}$.The.inter.planer.distances.(dspacing).have.been.calculated.using.the.Bragg`s.equation.and.are.given.in.table.(1)..

Table(1):.The.dspacing.of.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.prepared.at.80°C.after.annealing .at.400°C.for.2h.

| Phases | (2θ).°2Theta. | d-Spacing.(Å) | $h^2+k^2+l^2$ | Orientations | Lattice constant.(Å) | Lattice.Constant.(Å).in.text.book.[10-11]. |
|---|---|---|---|---|---|---|
| Ge(111) | 26.889 | 3.311 | 3 | (111) | 5.736 | 5.74 |
| Ge(211) | 38.626 | 2.328 | 6 | (211) | 5.702 | 5.6575.and.5.74 |
| Ge(220) | 44.953 | 2.014 | 8 | (220) | 5.700 | 5.6575.and.5.74 |

It.is.clear.from.x.ray.analysis.of.the.tw.sampe.that.crystallization.effects.occur.only.in.Ge.matrix.because.the.crystallizing.temperature.of.the.germanium.(abut. 300°C).is.lower.than.that.of.silicon.(.about.500ºC.)..This.also.indicates.that.zinc.atoms.are.located.between.crystalline multilayers,.that.atoms.also.conformational.bonds.with.the.surrounding.atoms..

Therefore..it.has..a.good.bond..and..reduces..crystal.defects..and..increases..electrical.conductivity.,.where.the.crystallization.effects.occur.in.the.sample. $Si_{10}Ge_{10}Zn_{80}$.more.than.the.crystallization.occur.in.the.sample.$Si_{10}Ge_{10}Te_{80}$.

#### 2.Optical.Properties

In.this.section.we.will.discuss.the. measurements.of.transmission.of.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films.prepared.at.80°C,.and.the.deduced.optical.energy.gap.after.annealing.at.400°C.

#### 2..1..Transmission.and.absorption. measurements.

Figures.(1).show.transmission.for.the .$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films.thin.films.after.annealing.atm400°C..It .is.clear.that.for.high.energies.($\lambda_{min}$).there.is.no.transmission.appeared.for.samples.but.for.low.energies.($\lambda_{max}$).the.transmission.is.high..For.low.energies.($\lambda_{max}$).h

E-ISSN 3007-4495
ISSN-L 3007-4495
Legal Deposit Number 313/2023
DOI https://doi.org/10.37376/ajhas.vi2
Frequency: Two Issues per year
Publication Fees are Free
Publisher: University of Benghazi, Benghazi, Libya
Editor-in-Chief Prof. Mohamed Lama
https://journals.uob.edu.ly/AJHAS
ajhas.journal@uob.edu.ly
+218924809776

Afaq Journal for Human and Applied Studies
Faculty of Arts and Sciences
ALAbyar University of Benghazi
ISSUE: 2 – August 2024
مجلة آفاق للدراسات الإنسانية والتطبيقية
كلية الآداب والعلوم الإبيار
جامعة بنغازي
العدد: الثاني - أغسطس 2024

owever.there.are.no.appropriate.electronic.transitions.possible.so.transmission.is.very.high.in.this.range..It.is.not.100%.however,.because.of.absorption..The.interpretation.of.the.transmission.spectra.in.figure.(1).is.not.so.straight.forward..For.high.energies,.where.absorption.is.high.according.to.the.transmission.chart,.increases.as.well..This.can.only.be.explained.by.a.theoretical.treatment.of.the.interaction.between.light.and.matter.[12.14].

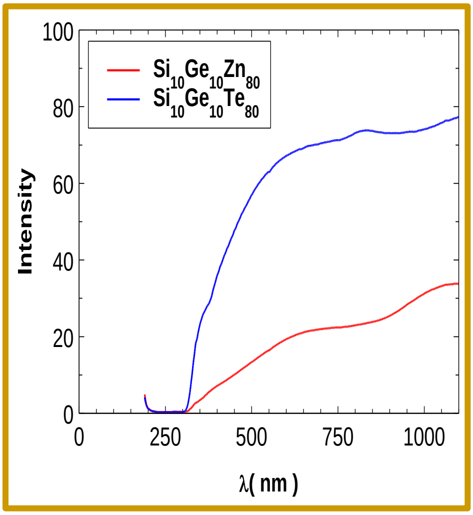


Figure.(1):.Transmission.spectra.for.untreated.the.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films.prepared.at.80°C.and.annealed.at.400ºC.for.2.h.It.is.shown.that.for.high.energies.($\lambda_{min}$).there.is.no.transmission.for.film.$Si_{10}Ge_{10}Te_{80}$.,but.for.film.$Si_{10}Ge_{10}Zn_{80}$.the.transmission.is.about.34%..For.high.energies.($\lambda_{min}$),.where.absorption.is.high.according.to.the.transmission.chart..After.annealing.at.400ºC,the.absorption.is.increases.due.to.the.increasing.of.crystallization.and.the.high.concentration.of.zinc.(Zn).which.leads.to.a.decrease.of.the.transmission.intensity...

**2.2..Optical.energy.data**

The.optical.band.gap.is.useful.material.parameter..It.allows.to.compare.between.the.samples.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films.based.materials.regarding.their.light.absorption.properties.[15.17]..The.concentration.of.tellurium.and.zinc.plays.an.important.role.for.determining.electrical.conductivity.and.the.optical.energy.gap.for.the.samples.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.,.as.conformed.by.the.results.obtained.in.previous.works[18]..Figures.(2)..shows.the.relation.between.$(\alpha h\nu)^{1/2}$.and.$(h\nu)$.for.the.two.samples..According.to.Tauc's.relation.[19],.the.optical.energy.gaps.were.deduced.from.the.plots,.and.the.values.are.given.in.tables.(2).for.the.two.samples.after.annealing..

Afaq Journal for Human and Applied Studies
Faculty of Arts and Sciences
ALAbyar University of Benghazi
ISSUE: 2 – August 2024
مجلة آفاق للدراسات الإنسانية والتطبيقية
كلية الآداب والعلوم الإبيار
جامعة بنغازي
العدد: الثاني - أغسطس 2024

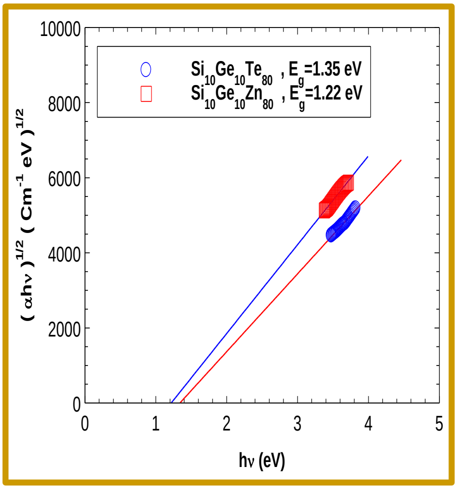


Figure.(2):.$(\alpha h\nu)^{1/2}$..Vs..hν.for. $Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films.prepared.at.80ºC.and.annealed.at.400°C.for.2.h.

The.data.shows.that.the.optical. energy.gap.is.decreases.with.raising. and/or.annealing.temperature.and.due.to.crystallization.effects.in.Ge.matrix.[20,23].,and.partially.due.to.high.concentration.of.zinc.(.Zn.).

Table.(2):.The.data.of.optical.band.gap.$E_g$.for.untreated.samples.

| The.sample | $E_g$.(eV.) |
|---|---|
| $Si_{10}Ge_{10}Te_{80}$ | 1.35 |
| $Si_{10}Ge_{10}Zn_{80}$ | 1.22 |

**3.Electrical.properties**

**3.1..Effects.of.temperature.and.(tellurium/zinc).high.concentration.on.the.electrical.conductivity.**

The.conductivities.as.a.function.of.temperature.for.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films.prepared.at. 80ºC.and.annealed.at.400°C.for.2.h.. Here,.the.concentration.of.Te.and.Zn.are.80%,.in.the.temperature.range.308.473.K.are.shown.in.figures.(3).It.is.seen.that.the.relation.between.the.electrical.conductivity.and.the.temperature.obey.the.Arrhenius.type.equation:$\sigma=\sigma 0.\exp(Ea/kBT)$.(1)

where.σ.is.electrical.conductivity,.Ea.is.the.activation.energy.and. kB.is.the.Boltzmann`s.constant..The. high.concentration.for.elements.conducting.are.playing.an.important.role.for.determining.electrical.conductivity.of.multilayers.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films..The.electrical.conductivity.measured.at.308.K.and.the.activation.energy.calculated.from. the.slopes.of.the.lines.for.the.samples.are.given.in.table.(3)..It.is.seen.that.the.electrical.conductivity.increases.while.activation.energy.decreases.with. increasing.the.content.of.(.Zn.).more.

Afaq Journal for Human and Applied Studies
Faculty of Arts and Sciences ALAbyar University of Benghazi
ISSUE: 2 – August 2024
مجلة آفاق للدراسات الإنسانية والتطبيقية
كلية الآداب والعلوم الإبيار جامعة بنغازي
العدد: الثاني – أغسطس 2024

than.(.Te.).as.conformed.by.the.previous.works.[18,22,23]..

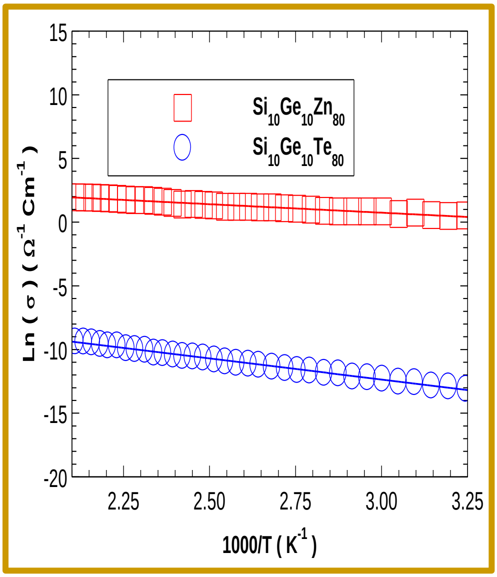


Figure.(3):.Dark.conductivity.vs..inverse.of.temperature.for.multilayers.of.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films.

Table.(3):.Conductivity.measured.at.308.K.and.the.activation.energy.for.untreated.multilayers.of.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films.

| The.sample | concentration.(80%) | $\sigma(\Omega^{-1}.cm^{-1})$. | $E_a$.(.eV.) |
|---|---|---|---|
| $Si_{10}Ge_{10}Te_{80}$ | Te | $26\times10^{-3}$ | **0.29** |
| $Si_{10}Ge_{10}Zn_{80}$ | Zn | $31\times10^{-2}$ | **0.12** |

### 3.2..Kinetics.and.thermal.stability

The.electrical.conductivity.of.multilayers.of.$Si_{10}Ge_{10}Te_{80}$.and.$Si_{10}Ge_{10}Zn_{80}$.thin.films.as.a.function.of.annealing.times.were.recorded.at.different.temperatures.473,573.and.673.K.is.given..figure.(4).and.(5),.respectively..All.samples.show.the.same.general.behavior.where.the.electrical.conductivity.increases.with..increasing.the.annealing.time..at.constant.annealing..temperature.and.becomes.constant.at.high.annealing.time..This.behavior.is.attributed.partially.to.crystallization.occurring.in.the.multilayers,.that.crystallization.effects.occur..only.in.Ge.matrix.with.annealing..temperature..and..annealing.time..as..confirmed.by.Xray.data,..and.also.depending.on.the.incorporation.of.zinc.or.tellurium.at.the.network.

It.is.known.that.the.conductivity.of.crystalline.material.is.higher.than.that.of.amorphous.one.since.the.ordered.systems.exhibit.lower.activation.energy.than.the.amorphous.one.[24].The.study.confirms.that.electrical.conductivity.increases.with.increases.at.high.concentration.of.the.element.doping..This.is.clearly.for.the.sample.doped.with.zinc.at.high.concentration,.more.than.for.the.sample.doped.with.tellurium..Thus..the.electrical.cond

E-ISSN 3007-4495
ISSN-L 3007-4495
Legal Deposit Number 313/2023
DOI https://doi.org/10.37376/ajhas.vi2
Frequency: Two Issues per year
Publication Fees are Free
Publisher: University of Benghazi, Benghazi, Libya
Editor-in-Chief Prof. Mohamed Lama
https://journals.uob.edu.ly/AJHAS
ajhas.journal@uob.edu.ly
+218924809776

Afaq Journal for Human and Applied Studies
Faculty of Arts and Sciences ALAbyar University of Benghazi
ISSUE: 2 – August 2024
مجلة آفاق للدراسات الإنسانية والتطبيقية
كلية الآداب والعلوم الإبيار جامعة بنغازي
العدد: الثاني – أغسطس 2024

uctivity..measurements..as.a.function ..of..annealing..time.at.constant..temperature..are.used.to..study.the.isothermal.crystallization..kinetics.using.Johnson.Mehl.Avermi`s.(JMA).equation..

Thus.the.electrical.conductivity.measurements.as.a.function.of.annealing.time.at.constant.temperature.are.used.to.study.the.isothermal.crystallization.kinetics.using.Johnson-Mehl-.Avermi`s.(JMA).equation.in.the.form[25]:.

$\chi.=.1.-.exp[-kt^n]$..(2)

Where.$\chi$.is.the.volume.fraction.of.the.crystalline.phases.transformed.from.the.amorphous.state.at.time.t,.n.refers.to.the.order.of.reaction.and.k.is.the.effective.overall.reaction.rate,.which.actually.reflects.the.rate.of.crystallization.[26,.27].

The.electrical.conductivity.as.a.function.of.annealing.time.the.volume.fraction.$\chi$.is:.

$\chi.=.(Ln.\sigma_a.-.Ln\sigma_t)/(Ln\sigma_a.-.Ln\sigma_c)$..(3)

Where.$Ln\sigma_a$.is.logarithm.of.the.electrical.conductivity.at.zero.time.(activation.electrical.conductivity),.Ln.$\sigma_t$.logarithm.of.the.electrical.conductivity.at.any.time.t.and.ln.$\sigma_c$.is.logarithm.of.the.electrical.conductivity.at.the.end.of.saturation.(full.crystallization).

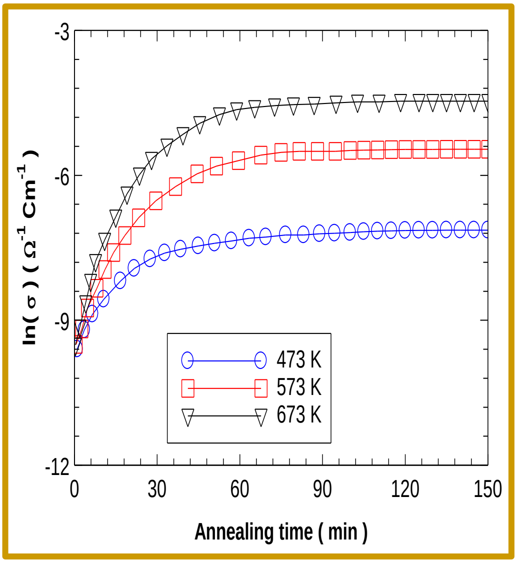


Figure.(4):.logarithm.of.the.electrical.conductivity.versus.the.annealing.time.at.constant.temperatures.for.$Si_{10}Ge_{10}Te_{80}$.multilayers.

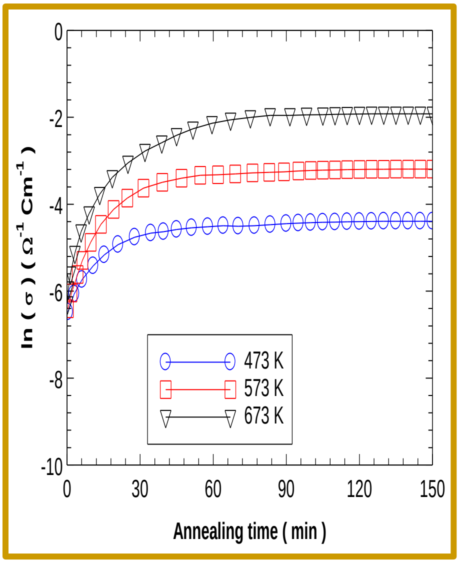


Figure.(5):.logarithm.of.the.electrical.conductivity.versus.the.annealing.time.at.constant.temperatures.for.$Si_{10}Ge_{10}Zn_{80}$.multilayers.

**IV.Conclusions**

The.samples.show.the.same.general.behavior.where.the.electrical.conductivity.increases.with..increasing.the.annealing.time.at.constant.annealing..temperature..and..becomes.constant.at.high.annealing.time..This.behavior.is.attributed.partially.to.crystallization.occurring.in.the.multilayers,.especially.for.germanium.atoms.depending.on.the.annealing.temperature.and.annealing.time.as.confirmed.by.Xray.dat,.and.due.to.the.incorporation.of.zinc.or.tellurium.to.the.network..The.elements.of.dopes.at.high.concentration.plays.an.important.role.for.determining.the.electrical.conductivity.and.optical.ga.in.this.study.the.conductivity.are.(ptype).similarly.for.holes..The.reason.in.changing.optical.gap,.this.may.be.due.to.shifting.the.Fermi.level,.where.increasing.shifting.the.Fermi.level.to.wards.the.valence.band.upon.zinc.or.tellurium.doping.in.the.thin.films..

It.was.found.the.electrical.conductivity.increasing..and.the.optical.gap.decreasing.with.the.crystallization..effects.occur.only.in..Ge.matrix.and.with..increasing.zinc.at.high.concentration..Where.the.optical.gap.change.from.1.35eV.to1.22eV.at.high.concentration.for.tellurium.and.zinc.respectively..It.is.clear.that.the.change.of.the.electrical.conductivity.with.annealing.time.at.different.isotherms.is.one.of.the.sensitive.physical.properties.to.reflect.the.change.and.growth.of.the.phase.transformation.process.of.any.material

**V..Acknowledgements**

My.great.thanks.are.due.to.Dr..Mohamed.Nawwar,.Dr..of.solid.state.physics,.Physics.Department,.Faculty.of.Science,.Menoufia.University,.E gypt.for.his.kind.an.immensely.help.in.achieving.my.goals..This.work.is.sponsored.by.the.Libyan.ministry.of.higher.education.and.Benghazi.University..

**References**

[1].C.N.R.Rao.and.K.J..Rao,.phase.transformation.in.solids,.91(1978)..

[2].D.Rurnbull,.solid.state.physics.e.seitz.and.turnobull.,.Accademic.press.New.York,.3(1959).

[3].M..Avrami,Chem..Phys.7,1103(1939).

[4].M.K..El-Mously.and.M.M.El-Zaidia,.J..Non-cryst-solids.27,265(1978).

[5].M.M.El-Zaidia.and.A.M.Nassar,.physics.and.chemistry.of.glasses.22,147(1981).

[6].M.M.El-Zaidia,.Ind,.J..Tech.,18,299.(1980).

[7].Deepika,K..S..Rathore,N..S..Saxena,New.Journal.of.Glass.and.Ceramics,.2,1(2012)..

[8].C.N.R..Rao.and.K.J..Rao,.phase.transformation.in.solids.93(1978)..

[9].J.N..Hay,.Brit..Polym..J,.374(1971).

[10].M..S..Abo.Ghazala,.E..Aboelhasn,.A..H..Amar,.and.W..Gamel,.Phys.Status.Solidi.C.8,.No..11–12,.3095–3098.(2011).

[11].B..Tillack,.P..Zaumseil,G..Morgenstern,.D..Kruger,.B..Dietrich,.G..Ritter,Journal.of.Crystal.Growth,.Vol..157,.pp..181-184.(1995).

[12].Z..Remes,.Ph.D.Thesis,.Faculty.of.Mathematics.and.Physics.of.the.Charles.University.Institute.of.Physics.of.the.Academy.of.Sciences.of.the.Czech.Republic,.Prague.(1999).

[13].B..Thangaraju,.and.B..Kaliannan,.J.Cryst..Res.Technol..35,.71(2000)

[14].O..Stenzel,The.Physics.of.Thin.Film.Optical.Spectra,.(Springer-Verlag,.Berlin,.Heidelberg.,.Germany).Press.(2005).

[15].J..M..Zahler,..A..Fontcuberta.Morral,.M..J..Griggs,.H..A..Atwaterand.Y..J..Chabal,.Phys..Rev..B.75,.35309.(2007).

[16].K..W..Jobson.and.J.P.R..Wells,R.E..I..Schropp,N.Q..Vinh,J.I..Dijkhuis,.J.Appl..Phys..103,.13106.(2008).

[17].Mursai,.S..Amiruddin,.I..Usma.T.Winata,.Sukirno,.and.M..Barmawi,Asian.J..Energy.Environ,.Vol.5,.Issue3,.pp..211-222.(2004).

[18.].Masheal.Ali.Alghamdi,.**Master.of.Science.,**.Department.of.Physics,.

The.University.of.King.Saud.University.(2008).
[19].J..Tauc,.in.Amorphous.and.Liquid.Semiconductors,.ed.(J..Tauc,.Plenum).159.(1974).
[20].Z..Li,.Ph.D.Thesis,.Iowa.State.Universty,.Ames,.Iowa.(2013).
[21].C..Wang,.D..Wuu,.S..Lien,.Y..Lin,.C..Liu,.C..Hsu,.and.C..Chen,.International.Journal.of.Photoenergy,.Vol 2012,.p..6.(2012).
[22].M..S..Abo.Ghazala,.P.hys..Status.Solidi.C.8,.3099–3102.(2011).
[23].C..Miha.,F..Sava,I..D..Simand.alca,.I..Burducea,.N..Becherescu.&.A. Velea,.Scientifc.Reports,.**11**:.11755.. (2021).
[24].A..A..Langford,.M..L..Fleet,.B.. P..Nelson,.W..A..Lanford.and.N..Maley,.Phys..Rev..B.45,.13367.(1992).
[25].J..A..Augis,.J..E..Bennett,.J..Thermal.Anal..13,.283.(1978).
[26].M..M..EL-Zaidia,.A..Shafi,.A.A.Ammar,.M..Abo.Ghazala,.J..Mat..Sci..22,.1618.(1987)
[27].Pradeep,.N.S..SaxenaA..Kumar. .Physica.Scripta.54,.207.(1996)