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A Stady on the Nano Structural, Electrical Properties of Tin and Chromium Nitride Using X-Ray Diffraction Techniques

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ABSTRACT: In this work the structural, optical and electrical properties of chromium nitride and tin were studied before and after the grinding process to know the mechanical effect on each of them using X-ray diffraction.

A sample of chromium nitride compound was ground for an hour, as well as tin granules were sprinkled by an iron machine to obtain tin filings, then the tin filings were ground for two hours, and they were converted into a powder.

The results of the X-ray diffraction measurements of the samples showed that the chromium nitride compound samples have a primitive hexagonal crystal structure, and the tin samples have a quaternary crystal structure. And there was a clear decrease in crystalline size for both samples, as it decreased by 34.74 nm / mol for chromium nitride compound samples, and for tin samples it was reduced by 6.15 nm / mol .

The optical properties of the samples before and after grinding were studied by recording the transmittance and absorption spectra and the wavelength range (190-1100 nm). It was found that the absorbance decreases after grinding for all samples and the transmittance increases. The results showed that the optical energy gap values increased from 3.629 eV to 3.707 eV after grinding for chromium nitride and from 3.63 eV to 3.684 eV for tin.

The results of the optical measurements also included calculating the optical constants represented by (the refractive index, the damping coefficient, the dielectric constant in its real and imaginary parts, and the optical conductivity), and it was found that There is a decrease in the values of the inertia and refractive index after grinding.

KEYWORDS: Nano Structure, x-ray diffraction, optical properties, electrical properties.

INTRODUCTION

The Scientific-technological and industrial progress go hand in hand with development of materials science and are related with the development of measuring tools where new features are quickly obtained. The large development raised the interest of researchers in solid state physics how to continue to find new materials from the environment and primary available elements or treatment of materials (Nanotechnology) to change and improve their properties. The finest examples of these achievements, plastics turn into connected to an electrical, optical fiber has become the transporter of billions of data across the globe, semiconductors have varied forms and so become the alternative to save energy by using solar cells or by electrical and electronic components inside the devices and machines were reduced energy consumption. The subject of this thesis is Chromium nitride compound and tin metal, those attracted the interest of researchers.

Transition-metal nitrides (TMN) have a great technological importance due to its interesting physical properties such as extreme hardness, high melting temperature, high reflectivity, corrosion resistance, abrasive resistance, diffusion resistance, good stability at high temperatures, and good electrical and optical properties, etc., which makes them suitable for many important technological applications. These compounds used in engineering technology fields, such as metallurgy, electronic industries, high-temperature structural ceramics, microelectronic devices, industrial catalysts and in composites with other materials, which can improve their properties and even reveal new applications [1-5].

Among the transition metal nitrides, Chromium nitride (CrN) is of great technological importance due to its high mechanical hardness, high thermal stability and resistance to corrosion and mechanical strength and has therefore become an important material for protective and abrasion resistant coatings. In addition to technological interests, this compound also has very interesting basic physical properties [1,6-8].

MATERIAL AND METHOD

MATERIALS PREPARATION

Chromium Nitride Powder

Chromium Nitride powder sample was purchased from Alfa Company (local known company), after the sample was ground in mortar for 1 hour, as. shown in Figure (1).

Figure (1): Chromium Nitride powder

Tin Granule

Tin granule of high purity was procured from the Chem-Lab Company. After that Tin granule were crushed by machine of iron for get Tin filings. Shown in Figure (2). Then the Tin filings was ground in a mortar for 2 hours, it was converted into powder. Shown in Figure (3). Finally, some quantity of the Tin powder was ground in mortar for 1 hour again to obtain a smoother material

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Figure (2): Tin Filings

Figure (3): Tin Powder

X-ray diffraction (XRD) Analyzing

X-Ray Diffractometer (XRD)

X-ray powder diffractometer is the basic tool on studying and identifying the composition and structure of material. The X-ray diffractometer (XRD) characterizations in this study were performed with XRD spectroscopy (Persee Analytics Inc, XD-2IXD-3) shown in figure (4), using Cu Kα with maximum speed of 120°/minutes, it was used to examine the structure of samples before and after process grinding. The specifications of the device used are shown in the table (1).

Table 1: specifications of X-Ray Diffractometer (XRD)

Component	Specifications
Type	Cu Target,NF Model
Focus Dimensions	1.0×10mm^2
Maximum Power	2 KW
X-ray Tube Voltage	15kV ∼ 60kV
Tube Voltage Step Width	1kV
X-ray Tube Current	6mA ∼ 50mA
Tube Current Step Width	1mA
Goniometer Type	Vertical(θ-2θ)
Scanning Radius	180mm
Scanning Mode	θ-2θ Linkage Or θ,2θ Single Move
Measurement Range	-182° ∼ 182°(θ) -30° ∼ 160°(2θ)
Continuous Scanning Speed	0.125°/min ∼ 120°/min
Minimum Step Size	0.00025°
The Type Of Detector	Scintillator Counter
Crystal Type Of Detector	NaI
Ni Filter	Corresponding Cu Target

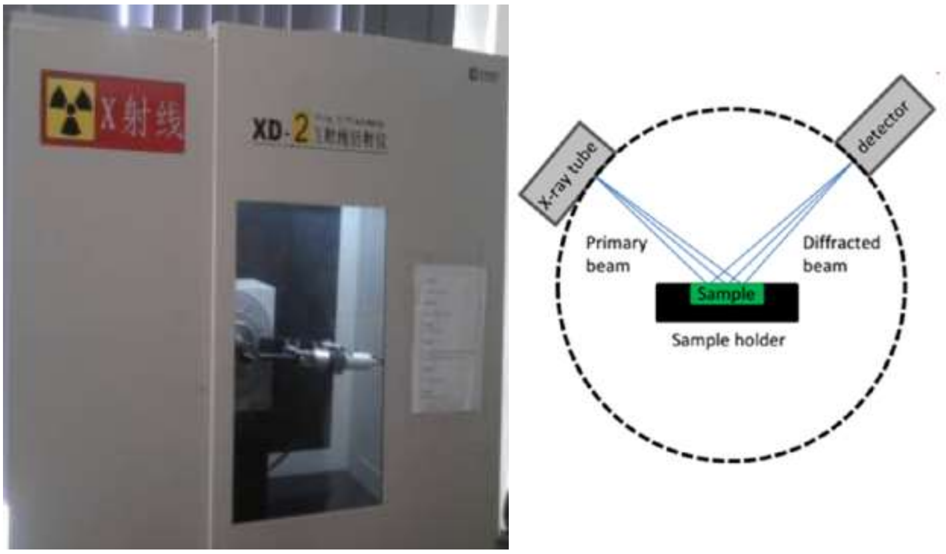

Figure (4): X-ray diffractometer

X-Ray Diffraction (XRD) Results of All Samples:

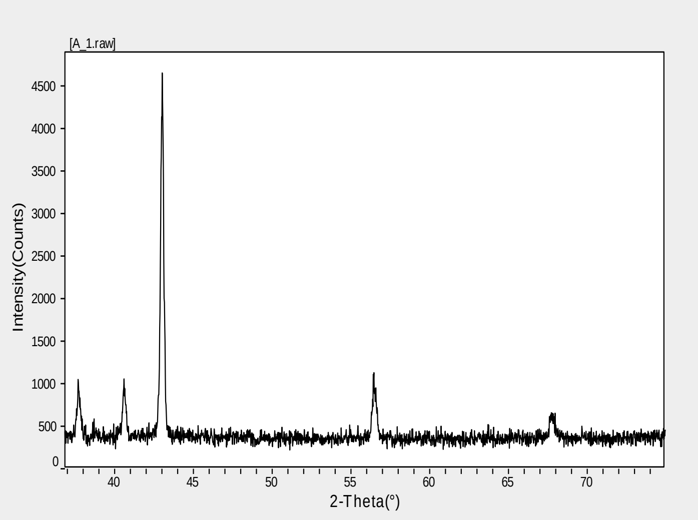

Figure (5): XRD spectrum of Cr_2N before grinding

Table (2): Calculate Lattice Constants from Peak Locations and Miller Indices [Hexagonal –Primitive] of Cr_2N before grinding.

2Θ	d (10^{-10} m)	h k l	G_s (nm)
37.7414	2.38763	1 0 0	100
40.7195	2.22250	0 0 2	85.4
43.0918	2.10340	1 0 1	50.6
56.7224	1.62680	1 0 2	91.7
68.1396	1.37850	1 1 0	69.6

a= 2.75 b = 2.75 c= 4.428 * $\alpha = \beta = 90^{O}$ $\gamma = 120^{O}$.
Density = 7.1644 $mg.cm^{-3}$.
Crystal Form: Hexagonal –Primitive.
Space Group: P63/mmc (194).

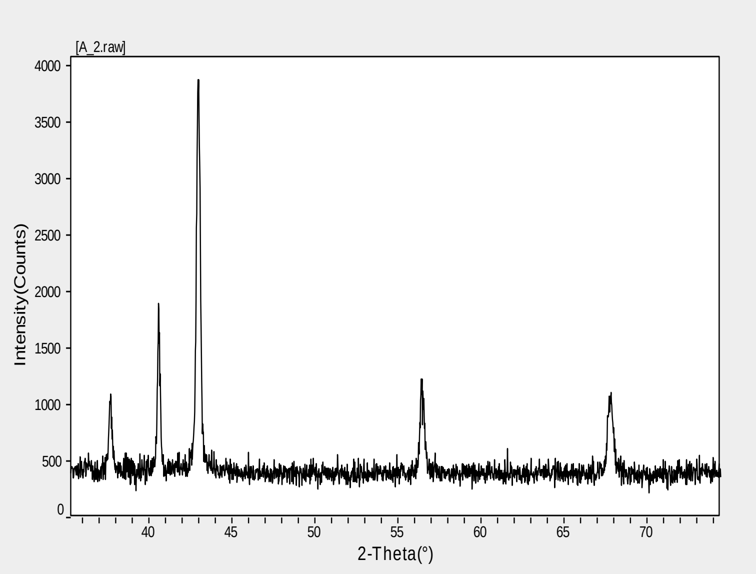

Figure (6): XRD spectrum of Cr_2N after grinding

Table (4) Calculate Lattice Constants from Peak Locations and Miller Indices [Hexagonal –Primitive] of Cr_2N after grinding.

2Ɵ	d (10-10 m)	h k l	Xs (nm)
37.7414	2.38157	1 0 0	52.8
40.7195	2.21400	0 0 2	62.1
43.0918	2.09745	1 0 1	37.5
56.7224	1.62154	1 0 2	43.1
68.1396	1.37500	1 1 0	28.1

a= 2.75 b = 2.75 c= 4.428 * $\alpha = \beta = 90^{O}$ $\gamma = 120^{O}$.
Density = 7.1753 $mg.cm^{-3}$.
Crystal Form: Hexagonal –Primitive.
Space Group: P63/mmc (194).

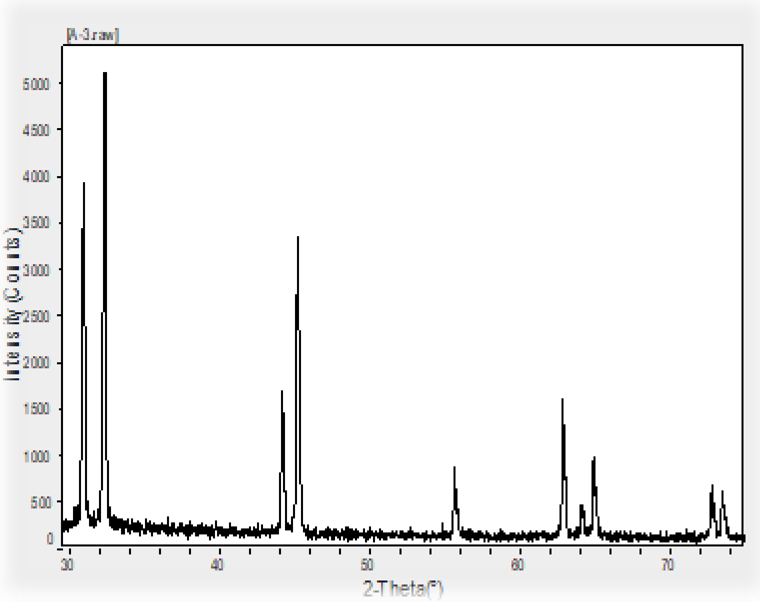

Figure (7): XRD spectrum of Sn - Tin before grinding

Table 4.4: Calculate Lattice Constants from Peak Locations and Miller Indices [Tetragonal –I-Center] of Sn-Tin before grinding

2Ɵ	d (10^{-10} m)	h k l	G_s (nm)
30.6347	2.91590	2 0 0	50.5
32.0159	2.79319	1 0 1	49.9
43.8739	2.06185	2 2 0	100
44.9004	2.01707	2 1 1	50.0
55.3357	1.65885	3 0 1	57.0
62.5233	1.48431	1 1 2	42.9
63.7855	1.45795	4 0 0	40.8
64.5831	1.44186	3 2 1	53.9
66.9456	1.39660	2 0 2	100
72.4122	1.30403	4 1 1	100

a=5.8318 b=5.8318 c= 3.1819 * $\alpha = \beta = \gamma = 90^{O}$.
Density = 7.2861 $mg.cm^{-3}$.
Crystal Form: Tetragonal –I-Center.
Space Group: 141/a m d (141) (origin at -4).

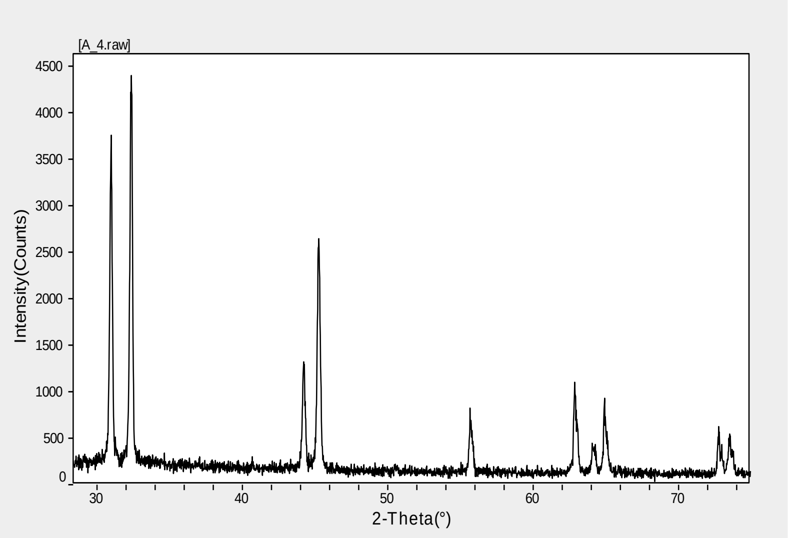

Figure (8) XRD spectrum of Sn - Tin after grinding

Table (5): Calculate Lattice Constants from Peak Locations and Miller Indices [Tetragonal –I-Center] of Sn-Tin after grinding

2ϴ	d (10^{-10} m)	h k l	X_s (nm)
30.6347	2.89389	2 0 0	52.7
32.0159	2.77178	1 0 1	51.2
43.8739	2.05506	2 2 0	100
44.9004	2.00860	2 1 1	62.0
55.3357	1.65228	3 0 1	52.8
62.5233	1.47927	1 1 2	51.2
63.7855	1.44954	4 0 0	16.0
64.5831	1.43475	3 2 1	50.3
66.9456	1.30067	2 0 2	86.9
72.4122	1.28901	4 1 1	60.4

a=5.8318 b=5.8318 c= 3.1819 * $\alpha = \beta = \gamma = 90^{O}$.
Density = 7.2947 mg.cm^{-3}.
Crystal Form: Tetragonal –I-Center.
Space Group: 141/a m d (141) (origin at -4).

Table (6): some crystallite lattice parameter (c- form , a,b,c, β,α, γ, Xs(nm) and d – spacing) of all samples that meade by (Cr_2N and Sn - Tin).

Sample	Gs(nm)	d-spacing (A°)
Cr_2N before	79.46	1.943766
Cr_2N after	44.72	1.937912
Sn-Tin befor	64.50	1.853161
Sn-Tin after	58.35	1.833485

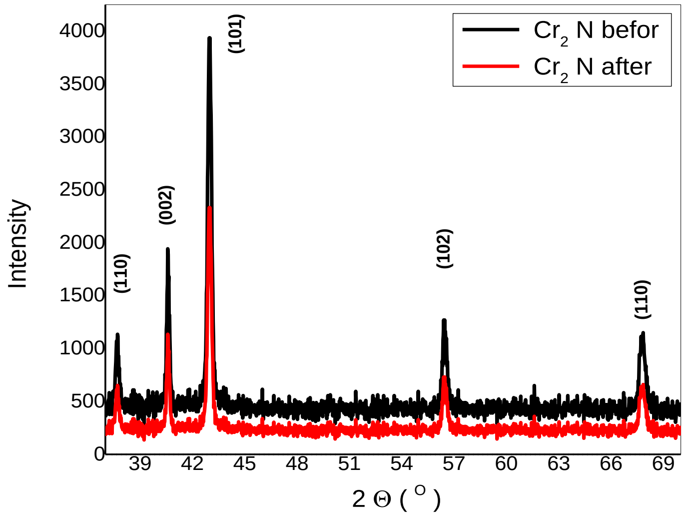

Figure (9): XRD spectrum of all Cr_2N samples

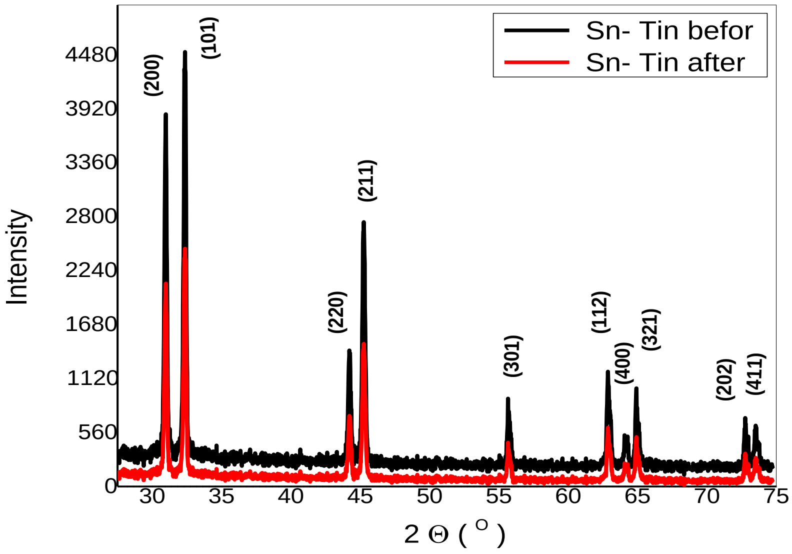

Figure (1): XRD spectrum of all Sn - Tin samples.

CONCLUSION AND DISCUSSION

The crystal structure of all samples characterized at room temperature using a Persee Analytics Inc, XD-2IXD-3 X-ray diffractometer (operated at 60 kV and current of 50AM) and samples were scanned between 50^O and 70^O at a scanning speed of 0.125°-120°/min using Cu Kα radiation with λ = 1.5418Å.

The representative XRD charts of all (Cr_2N and Sn - Tin) samples as show in Figure (5) to Figure (10). Miller indices provided in the figure and all peaks determine transformation of dried powder to (Cr_2N and Sn - Tin)samples crystalline with Hexagonal- Primitive rutile crystal structure for Cr_2N samples, and Tetragonal –I-Center for Sn-Tin samples, and this agree with the results of published research.

Tables (2) to (6) show the XRD parameters of all (Cr_2N and Sn - Tin) samples Nano powder at various crystalline orientations. In table (6) shows that the d- spacing of all (Cr_2N and Sn - Tin) samples nanoparticles, and noticed that the rated of decreasing the d- spacing of (Cr_2N) samples by the rated 0. 005854 nm / molar after the grinding, and for Sn-Tin samples decreasing by the rated 0.019676 nm / molar after the grinding. And for the crystalline size of all (Cr_2N and Sn - Tin) samples, decreases by rated 34.74 nm / molar for samples Cr_2N, and for the Sn-Tin samples was decreases by rated 6.15 nm / molar for samples.

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