RAMAN STUDIED ON CUPRIC TELLURIDE THIN FILMS

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Abstract
Copper telluride thin films have been prepared utilizing an electrodeposition method on various substrates. The ITO electrode in white and Cu solution are used and H₂SO₄ has been used to help electrolyte for CuTe film development. The thickness value of the film deposited has been determined by stylus profilometry. An study of X-ray diffraction showed a polycrystalline nature in prepared films. The bands of the Raman were well balanced with the frequencies measured. The Raman spectra composed generally of completely symmetrical high-intensity modes superimposed on single-tone signals of decay.

Keywords: Copper, Telluride, Profilometry, Isolation, Raman

1. Introduction
Thin film technology is one of the oldest and most recent arts. It was used earlier for decorating sculptures, walls, mirrors, etc. Integrated circuits are thin films' direct applications. Thin film science has become a global field of study. Thin films have been introduced in diverse sectors and modern content synthesis have culminated in an unprecedented growth in revolutionary developments for thin films. These devols are now followed by a revolution of microelectronics, optics and nanotechnology in science or technical type. A thin film has a two-dimensional look since it is negligibly limited in thickness (of the order of a few nanometres to a few micrometres). It varies entirely from its bulk component in this two-dimensional feature. The volume-to-surface ratio of thin films is higher than in bulk. Furthermore, polycrystalline films have an overall size of crystallites. In addition, different defect forms exist in thin films in significant numbers. Micro-Raman spectrometer studied the gill motions in thin films of these compounds [1-5].

The usage of different methods, such as low cost chemical processes, can be used to manufacture thin film and nano-material coffee oxide. In contrast with Cu₂O, because of its narrower optical band difference, CuO is superior for solar power harvesting. CuO can absorb the entire visible light spectrum, while Cu₂O can absorb a wavelength of less than 620 nm only to the light component. In addition, CuO is more stable in air and Cu₂O will oxidize into CuO at higher temperatures. CuO has been highly interested in recent years as a result of its successful application to harness solar energy. There have been several research and development projects to increase the conversion efficiency of CuO, small-scale and experimental equipment from 10 to 5 percent to 3 percent. Consequently, this material system is now used as the foundation of terrestrial energy production photovoltaic modules technologies. These solar cells are, in
comparison, very durable and therefore have a longer service life. Several methods were used in the preparation of CuO's film: sputter, electrodeposition, deposition of chemical vapor, and sol-gel methods. The protocol was also pursued. Among these, ultrasound spray pyrolysis has become very desirable because it is an easy and inexpensive technology. Although CuO's deposited thin films have good optical characteristics relative to those that are deposited with other technologies, they have proved themselves to be the most appropriate for solar cells [6-10]. The simple regulation of the deposition parameters, on the other hand, ensures that the properties necessary for each application are regulated. It is well known to be very susceptible to deposition parameters for film products regardless of the form of deposition. The structural, optical and electrical properties of the CuO substrate have a dramatic effect on CuO gas sensor and solar cell characteristics and efficiency.

Neyvasagam, Karuppathevar (2007). Small cupric telluride (CuTe), thin films of 100 nm and 200nm thickness, deposited at 15.3 A/s on a well-cleared glass substratum at 300 km under vacuum better than 10(-5) bar have been formed by the thermal evaporating technique. The Adorable bulk sample was also taken for testing. The films which were deposited were reconstructed for one hour at 375 K and then used to classify them. The CuTe bulk content Raman spectrum has been recorded and the CuTe thin films. The compositions and polycristalin existence of Adorable movies have been verified in X ray diffraction tests. Ramans were observed in both slim and bulk Adorable films at 231 cm⁻¹, 240 cm⁻¹ and 259 cm⁻¹. The peak location of CuTe films in Raman was not substantially modified, although the peak strength was increased. CuTe thin films have a grain size of around 40nm, determined by measurements of the Atomic Force Microscopy (AFM).

Pathan, Habib (2003) The usage of changing the copper (II) sulfate form was deposited in Copper Telluride thin films, respectively as cationic and anionic streams, [CuSO4·5H2O] and [Na2TeO3]. The updated chemical approach is based on submersion into cationic and anionic precursors separately positioned. In order to achieve quality copper Telluride Thin Films at room temperature, prepared conditions such as concentration, pH, immersion duration, immersion cycles etc were optimised. Films have been constructed with the help of X-ray (XRD), SEM, energy scanning X-ray analyze (EDAX), Rutherford back scattering (RBS), optical absorption, electrical resistivity, and thermoemm measurement techniques for the structural, compositional, optical and electrical transmission properties.

Pushpendra Kumar (2009) This research discusses a large-scale, non template, low-cost and aqueous solution approach to synthesizing transitional metal chalcogenide in its nanorrheism. Almost standardized green copper telluride luminescent (Cu2Te) nanoparticles (NPs) were synthesized by wet chemical process with a single reaction to 70 °C in 9 hours. The system guarantees that the precursors with a very large output return are utilized approximately entirely. The product was defined by X-ray diffraction, UV spectroscope (UV-vis), Fourier infrarot spectroscopic transformation (FTIR), photo-light spectroscopy (PL) and atomic force microscopic techniques (AFM). • High resolution transmission electron microscopy (EDM). Analysis of XRD, TEM and HRTEM shows that the particles are between 25-30 nm of diameter.
In order to prevent a disruption of growth of nanocrystals (existing in the reaction mixture) from the isolation of the next alkalinity, the mentioned Protocol allows for precise control and synchronised isolation of Cu2Te alkals with specified size [10-15].

2. Experimental

CuTe and Cu2Te alloys from M/s Aldrich, India, were used for the preparation of thin films through thermal evaporation with 99.99 percent purity. Based on the thickness, the desired substance was taken and a maximum load of $2 \times 10^{-5}$ mbar on $0.01 \times 0.03$ m$^2$ well-purified glass substrates was evaporated from the molybdenum boat into a vacuum that approached. Until being installed in the vacuum chamber, the glass substrates were washed with warm chromic acid and water. The thin thickness films CuTe and Cu$_2$Te were deposited between 60 nm and 300 nm. A Z80 optical quartz-crystal thickness sensor was used to monitor the thickness of the films and the deposition intensity.

2.1 Thin Film Deposition

An electrochemical workstation CHI 660A was used for electrochemical experiments (CH Instrument, USA). The deposition was done with the counter electrode Ag/AgCl/sat in a three-electrode cell with the platinum mesh. As an electrode reference, KCl. The slide (NOT 20 / cm) was used as a working electrode with doped indium tin oxide (iTO). The ITO substratum was ultrasonically washed sequentially by acetone, ethanol and water before electrodeposition. Both solutions were formulated using nanopure water filtered by a Milli-Q method and all chemical compounds were analytical in grade (Millipore Inc., nominal resistivity 18.2 M bis cm). Prior to each test the oxygen was extracted by blowing filtered N2, and the whole experiment was carried out at room temperature.

The ITO electrode in white and Cu solution are seen in figure 1. H$_2$SO$_4$ has been used to help electrolyte for CuTe film development. Just one pair of redox peaks at $-0.52$ V (B1) and $0.40$ V (B2), respective of the Cu$^{2+}$ reduction to Cu, have been observed from figure 1(a2) as reaction reveals Cu$^{2+} + 2e^– \rightarrow$ Cu.

![Cyclic voltammograms of ITO electrode](image-url)

*Figure 1*: Cyclic voltammograms of ITO electrode
2.2 Film Growth
The quantum Cu$_2$Te points is synthesized by an electrodeposition process at room temperature. Room temperature deposition protects metallic substrates from oxidation and corrosion. Chemical deposition contributes to pin hole-free deposits which is readily produced since simple construction blocks are ions rather than atoms. The precursor has been optimized with preparatory parameters including deposition period and concentration. In the conventional synthesis, (0.1 M) copper sulphide (CuSO$_4$) and (0.005 M) sodium telluride (Na$_2$TeO$_3$) are used to produce tests using the source of copper and telluride, while tri-ethanolamine is used to make a composite agent. Solutions are formulated in double distillated water. The anode used a plate of pure graphite, the cathode used with stainless steel and the reference electrode was a saturated calomel electrode (SCE). Appearances were collected in blackish grey, flat, consistent Cu$_2$Te thin films. In the present work, the excess copper ions decrease with growing deposition period, and the thin films become more adhesive and stoichiometrical because of the defined concentrations and shifts in deposition times. At 15 minutes, further stoichiometry is seen.

3. Structural Properties
XRD measurements on the films have been rendered to examine systemic improvements by consistently applying Cu to the goals. The thin film generated using the goal with [Cu]/[Te]=1.25 appears in figure 1(a). The first three big division planes of 10 to 40 degrees were shaped parallel to the preferential direction (0 0 c). These are part of the CuTe crystallized process, also referred to as vulcanite, (PDF no. 22–0252). Other low intensity peaks in higher angles are often in the same crystalline phase. This is an exceptional finding as most of the thin Cu$_2$-xTe films recorded to date display substantial crystalline mixtures, although this thin film crystalline structure only contains the vulcanite step. In comparison, none of the other films generated from the other goals observed this process [16].

There was a combination of stages with the majority of the thin films. Te diffractogram as seen in fig.1 (b) of the sample produced out of [Cu]/[Te]=1.5. In this case, the Cu$_7$Te$_5$ crystalline phase is dominant, its maximal intensities equivalent to a 26.66 degrees plane (052), while the PDF# 10–0421 (Space Group P3m1), the hexagonal phase, is not so much a contributory to 24.73 degrees (200). It should be made clear that this copper telluride process is commonly named as Cu$_2$-xTe in the PDF#10–0421; we have thus adopted the same notation in the figure1(d). Similarly, the fractional pattern of the film sprouted with the aim [Cu]/[te] ratio of 1.75 has the same peaks at high intensity that lead to the same phases’ mixture: richardiid and white, Fig. 1(c). Figure 1(d) [Cu]/[Te] =2, Cu$_7$Te$_5$ dominancy is diminished due to the growing existence of the Cu$_2$-x, Te hexages by the emergence, at angles greater than 40 degrees (119) and (209), of bipartition lines corresponding to the planes (119).
4. Diffusion Control

Figure 3 indicates the copper ion concentration represents the current intensity for ratio Cu/Te that reflect a number of tellurium concentrations: (a) no tellurium. Extrapolation of the experimental plots when the shot lines in the figure is seen. With the raised copper ion concentration, the restricting intensity of the current increased linearly. Therefore, simultaneous deposition of tellurium showed a low effect on the restricting current density for copper diffusion.

Diffraction patterns of the sputtered films with increasing [Cu]/[Te] ratio
5. Controlled Diffusion Within Thin Film

The [Cu]/[Te] ratio is modified, with a steady telurium concentration. Both films were potentiostatically deposited at 0.4 V, and the current density should be controlled by a diffusion rate only, as previously seen. The films were about 1.02 mm thick and accumulated about 2 mm h$^{-1}$ at 3 A m$^{-2}$. Figure 6 demonstrates the film structure in relation to eq-related estimates through ICP review. With respect to the solution [Cu]/[Te] the Cu/Te ratio film was linear. Moreover, eq. below the relationship correctly expressed in the experimental findings.

$$R_f = \frac{152(\pm12) [Cu]}{415(\pm12) [Te]} = 0.72(\pm0.02) \frac{[Cu]}{[Te]}$$
6. Raman Instrumentation

Inelastic dispersion of monochromatic laser light by molecule takes benefit of Raman spectroscopy. Laser energy is interchanged by molecules in order to raise or decrease the energy of the dispersed photons versus that of the incident photons. The energy disparity is a variation in the spinning and vibratory force of the molecule and tells regarding the levels of molecular energy. Because numerous molecules have different changes in energy, the Raman methodology may be used as a qualitative or quantitative form of study. For the determination of molecular structures, for the position of different chemical bonds or functional groups in molecules and for the quantitative analysis of complex compounds, Raman spectra were a significant tool [17]. A function of Raman dispersion is that the polarization of every line gives additional details on molecular structure. The polarization details are also possible. Vibrations of the lattice, i.e. translational and torsional molecules movement of a latrine under 300 cm\(^{-1}\) are causing (phonon modes). The Raman spectrum was obtained at room temperature in the vibrational grid modes of the copper telluride compound. Peak in the Fig detected. The peak, in figure 3, which is only active with Raman, appears on 257 cm\(^{-1}\) in mode A1. There are two peaks of E symmetry at 291 and 349 cm\(^{-1}\). The vibration of metal–ligand compounds such as triethanolamine is the product of peaks at 382, 424 cm\(^{-1}\). Because of the increasing deposition time intermolecular coupling between Cu and Te will result in the splitting of the peak (frequency) and bands. The XRD exposes the hexagonal process. No more studies on Raman copper telluride spectrum thin films are known.

![Fig. 5. Raman spectroscopy of Cu\(_2\)Te](image)

An study was carried out at room temperature in both bulk and thin film copper tellurides. The Raman bulk- and thin-film spectrum modes are identical. Three lines of Raman are found in cupric telluride (CuTe) thin films. The most intense line of the three Raman lines is 257cm\(^{-1}\). This is since Te-Te spreads Te atom vibration and is allocated to A1 mode. Eight Raman lines with a high strength of 147 cm\(^{-1}\) have been reported for A1 (bending), 217 cm\(^{-1}\) for B1 modes
(ant symmetrical extension) and 298 cm\(^{-1}\) for A1 mode have been substituted by eight Raman lines (Symmetric stretching).

**Conclusion**

The Cu/Te ratio of the film demonstrated a linear association with the [Cu]/[Te] ratio of the solution of inductively coupled plasma (ICP). The deposition capacity in the Cu/Te ratio of the film was barely any variation. Crystalline Cu\(_2\)Te movies were obtained with potentials from 0:25 to 0:55 V vs Ag/AgCl. Copper-tellurium was deposited with epitaxial electrodeposits in potentiation conditions layer by layer. XRD analyses of the CuTe and Cu\(_2\)Te thin films affirm the consistency of the deposits and prove that the deposition of stoichiometric nanofilms of copper tellurium strong quality is applicable to the deposition of the electrodeposition. The morphology of the surface displays the Cu\(_2\)Te hexagonal. These hexagonal nanograins are turned into quantum dots and the deposition period rises. The Raman change observed at the 270 cm\(^{-1}\) wave number confirms the development of hexagonal telluride copper. The optical characteristics of these films enable them to be adapted to solar control and photovoltaic systems. There is a finding that a narrower band gap is seen in more copper rich thin films.

**References**


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