THE OCCURRENCE AND CRYSTAL STRUCTURE OF TUNGSTEN BEARING ORES-MINERAL AT KANBOUK, TANINTHARYI REGION (MYANMAR)

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Abstract

Tungsten is a metal of superlatives and the lowest vapour pressure and the lowest expansion coefficient of all metals. The quality and the costs of producing the metal greatly depends on the efficiency of the concentrating steps performed at the rather limited number of mining sites. In this work, the tungsten (W) and tin (Sn) were produced in wolframite ore from Kanbouk mine by calcinations process and their structural properties were analyzed by using X-ray diffraction method. The elemental analysis was done by Energy Dispersive X-rays Fluorescence (EDXRF) method. The electric and magnetic properties of these samples were also observed PERMAGRAPH L and LCR meter.

Keywords: Tungsten, LCR meter, Wolframite, X-ray diffraction

Introduction

Tungsten ore is a rock from which the element tungsten can be economically extracted. The ore minerals of tungsten include wolframite, scheelite, and ferberite. Materials processing is one of the most important and active areas of research in heat transfer today. With growing international competition, it is has become crucial to improve the present processing techniques and the quality of the final product. Heat transfer is extremely important in a wide range of materials processing techniques such as crystal growing, casting, glass fiber drawing, chemical vapor deposition, spray coating, soldering, welding, polymer extrusion, injection molding, and composite materials fabrication.

The flows that arise in the molten material in crystal growing due to temperature and concentration differences, for instance, can affect the quality of the crystal and, thus, of the semiconductors fabricated from the crystal. Therefore, it is important to understand these flows and develop methods to minimize or control their effects. As a consequence of the importance of heat

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and mass transfer in materials processing, extensive work is presently being directed at this area. But what is often lacking is the link between the basic mechanisms that govern diverse processing techniques and the thermal systems needed to achieve the given process.

Tungsten is an economically important metal, being widely used in light-bulb filaments, electron and television tubes, abrasives and special alloys such as tool steels. Tungsten carbide is of great importance to the metal-working, mining and petroleum industries. Contamination from these sources is, therefore, possible in industrial and urban areas.

Experimental

Rock samples were purchased from Wolframite mine (Kanbouk), Tanitharyi region. Firstly, tungsten-ores alloys were divided and collected from rock sample according to their raw group formations (colour). The obtained raw samples were grounded with agate mortar and heated at 150°C, 300°C, 400°C and 500°C in furnace 3 hrs each and slightly cold down to room temperature. The samples were grounded again and again to form homogeneous powder. The powder samples were then added into the internal mixer 3 min after the blending started and allowed to mix for 4 min and were charged into the internal mixer. The powder samples were prepared with XRD holder to determine the structure and lattice parameter.

Small amount of annealed powder was characterized by XRD using Cu-K_α radiation at room temperature in order to check the phase purity and calculated average crystallite size. Once a homogeneous mixture is assumed after 13 min, the samples were pressed by hydraulic press machine into a measurement cell (1.3 cm diameter). The pellet samples were cured in a mold with a spacer approximately 0.5 mm thick and 1.3 cm in diameter. Dielectric measurements were carried out by a digital RLC meter (GWInstek LCR821) at room temperature. The dielectric constant and loss factor was measured over the frequency range 10 to 200 kHz. The measurements were performed applying a voltage of 1.5 V rms between the electrodes no. 1and electrode no. 2. Capacitive and resistance effects were determined through the measurements of permittivity and resistivity. The room temperature ferroelectric hysteresis loop measurement demonstrated the coexistence of ferroelectricity and magnetism was done by permagraph L equipment.

Results and Discussion

Structural characterization and elemental concentration

Figure 1.1 showed the XRD (X-ray diffraction) patterns of the powder samples. It was found that the powders were in tetragonal structure having p42/m n m space group. The average lattice constants are calculated to be a = 4.737Å and c = 3.185 Å from the refinement of the XRD data. The prominent peaks in the plot are indexed to various (hkl) planes of Cassiterite (Tin(IV)oxide (SnO_2)). The secondary peaks were observed in the form of wolframite (Fe, $MnWO_4$). The sample calcined at 400°C and 500°C are having stronger peak of (211) plane compared with other samples, but there have more other planes and impurities.

From the elemental analysis of wolframite ore samples, Tin (Sn), Tungsten (W), Iron (Fe), Manganese (Mn) were observed as major elements. When increasing of the treatment of annealing temperature, the concentration of Tin (Sn) element was decreased and the concentration of Tungsten (W) and Iron (Fe) were increased. Table 1.1 was shown the elemental concentrations of wolframite ore samples with heat treatment.

Surface morphology analysis

Figure 1.2 showed the scanning electron microscope (SEM) images of wolframite ore samples with different annealing temperatures. It was analyzed in a JEOL JSM-6400 scanning electron microscope at accelerating voltage of 20KVA, real time of 21-36 and live time of 60 seconds. There were two different types of morphological feathers along with voids are visible. The unreacted $MnWO_4$ grains which exhibit flowery feathers depict breaking up morphology, evenly distributed on the whole pellet surface. The increase in the furnace temperature enhances the rate of reaction and the images were formed faceted particles and agglomerated rods.

Dielectric measurements at room temperature

Figure 1.3 showed the dielectric constant measurements with respect to frequency in the region of (10 Hz-200 kHz) of wolframe pellets produced using PVA as a binder and applying pressure of 15 ton/cm^2 and using LCR meter. It was found that dielectric constant was higher in the lower frequency region. It decreases with increasing frequency and becomes almost constant at higher frequency region. It can be seen that the dielectric constant decreases with increasing frequency. It means that the dielectric constant of these samples were the strong function of frequency. The average dielectric constant of wolframe samples in the range 10Hz to 200 kHz at room temperature found to be ε_r = 35, 30, 25, 20, 10 respectively.

Resistivity measurement at room temperature

Figure 1.4 showed the electrical resistivity decreases and their electrical conductivity increases with increasing frequency applied. It can be said that the possibility of uses to these materials in high frequency device applications.

Magnetic hysteresis loop measurement

Figure 1.5 showed the magnetization of the wolframe simples as a function of applied magnetic field. Magnetization and magnetic hysteresis results confirm the absence of canted ferromagnetic behaviour in these simples. The measurement was carried out on the simples at room temperature. It is evident that magnetization is a linear function of applied magnetic field. Their magnetic remanences, normal coericity and maximum energy products were decreased but their intrinsic coericity values were increased with increasing annealing temperatures. It was said that this behaviour is the typical of antiferromagnetic materials.

Conclusion

Although the availability and quality of tungsten ores are limited and the price of the metal greatly fluctuates, its special physical properties and applications pose a reliable demand for production. The low tungsten content and the interference of the gangue minerals in the ore make it complicated and costly to provide a suitable concentrate for the metallurgical processing.

The primary objective of this work was the characterization of an ore bearing wolfrmite mineral from Kanbouk mine, Tanintharyi region. The XRD phase patterns confirmed the availability of minerals such as Cassiterite, Hubnerite and manganocolumbite. The chemical elemental composition determined by EDXRF was Tin (Sn), Tungsten (W), Iron (Fe), Manganese (Mn) as major elements and other trace elements were also found. The mineralogical studies carried out with SEM point imaging showed the presence of different aggregates of minerals.

A decrease in dielectric constant with increase of frequency was observed. This decrease was rapid at lower frequency ranges and slower at higher frequency ranges. It is observed that the dielectric structure is formed into two layers namely, the well conducting grains and poorly conducting grain boundaries. At very low frequencies, the oxide grain boundaries were more active and this contributes to the very high dielectric constant at low frequencies. Thus, it was found that they were a promising material for dielectric applications. B-H loop comfirms that the antiferromagnetic nature of the wolframe samples. Since the calculation values of permeability of these samples, it was said that their magnetic properties would transformed from diamagnetism to paramagnetism in sample annealing with temperature above 500°C.

Table 1.1: The elemental concentration in wolframite ore samples.

Elements	Concentration (%)				
	room temperature	Calcinations for 1 hour			
		150°C	300°C	400°C	500°C
Tin (Sn)	34.251	44.331	31.878	26.737	25.965
Tungsten (W)	26.949	25.390	26.330	26.897	28.353
Iron (Fe)	30.21	22.644	32.290	36.015	36.082
Manganese (Mn)	7.053	5.402	6.989	7.298	7.530

Table 1.2: The characteristic quantities of magnetic field in wolframite ore samples.

Sample	Remanence (B_r)(T)	Intrinsic coericivity (H_{CJ}) (kA/m)	Normal coericivity (H_{CB}) (kA/m)	Maximum Energy Product $(BH)_{max}$ (kJ/m^3)
Room Temperature	0.00391	11.6	3.2	0.00032
Annealing with 150°C	0.00349	37.6	2.89	0.00009
Annealing with 300°C	0.00237	66.4	1.91	0.0011
Annealing with 400°C	0.00196	72.08	1.57	0.00114
Annealing with 500°C	0.000951	90.9	0.749	0.00001

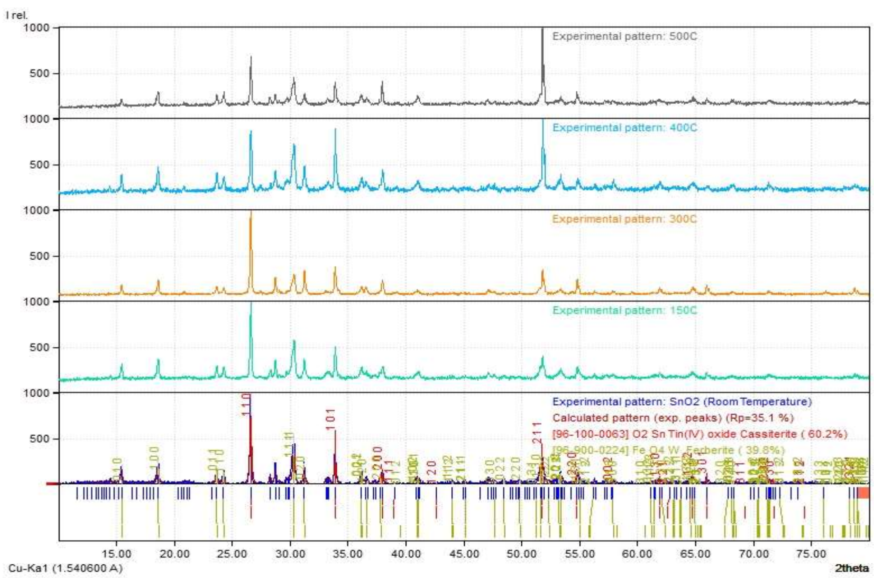

Figure 1.1: The XRD patterns of wolframite samples

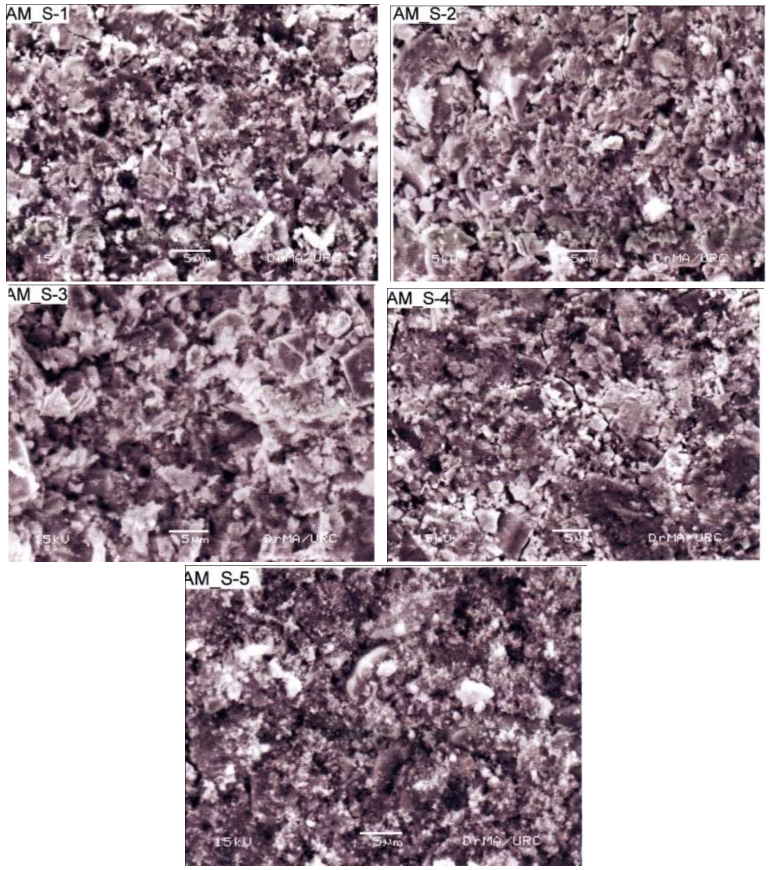

Figure 1.2: The SEM image of wolframite samples with different annealing temperatures.

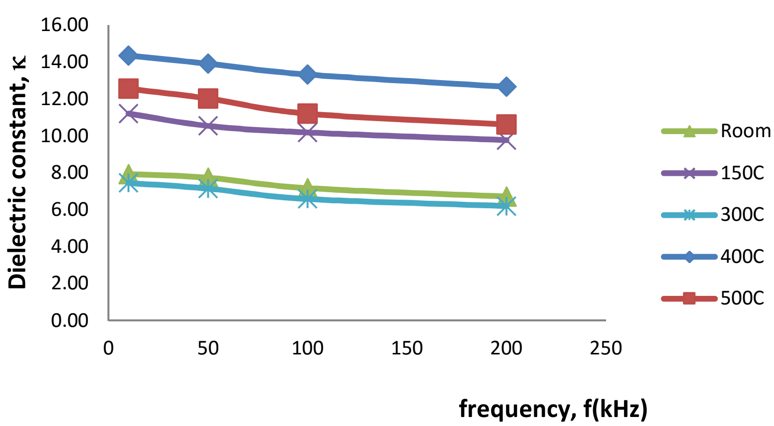

Figure 1.3: The capacitive effects of wolframite samples

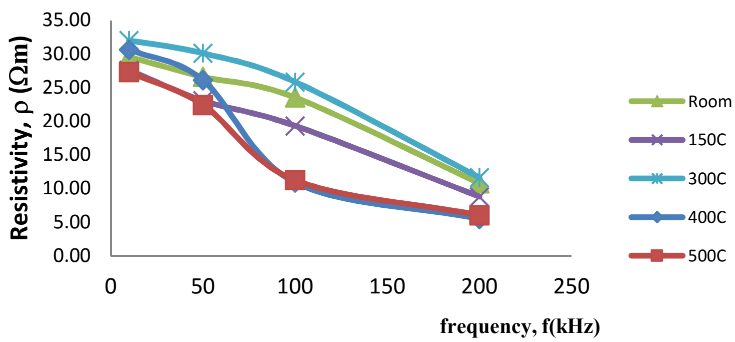

Figure 1.4: The frequency dependence resistivity of wolframite samples.

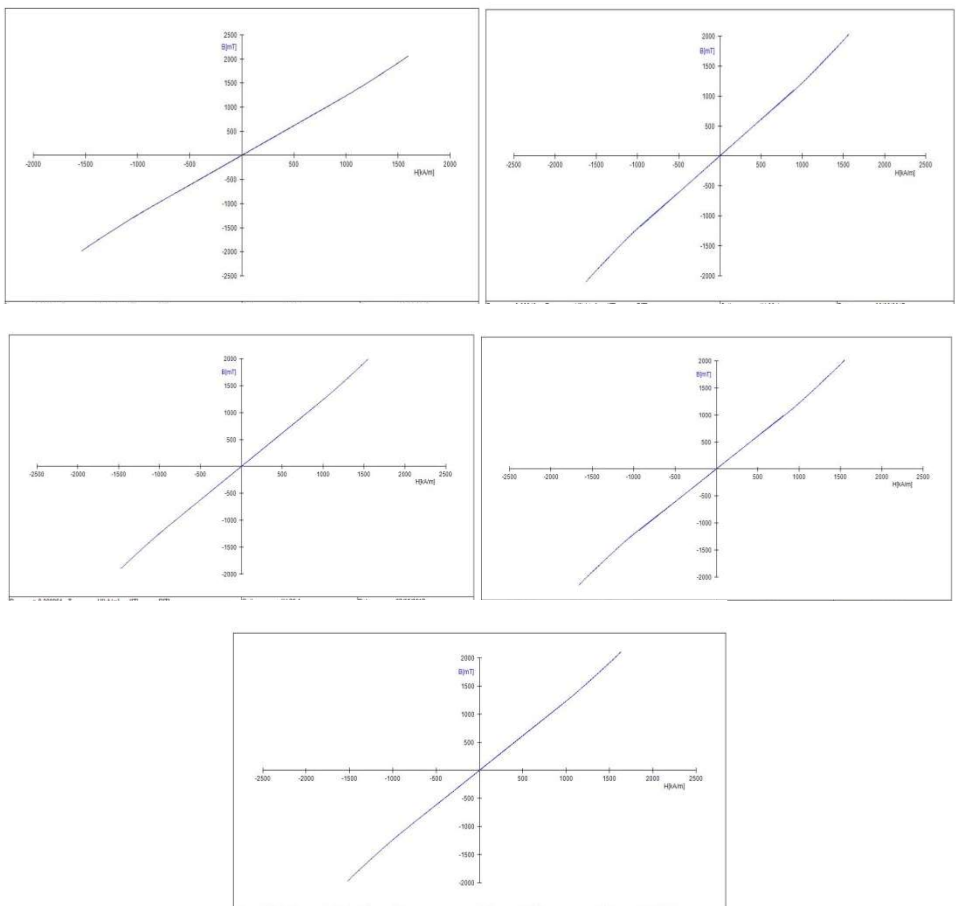

Figure 1.5: The Magnetic properties of wolframite samples

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