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The Most Important Reason to Educate Students with Knowledge to Measure Refractive Index: Evaluated From The Impact On Judd-Ofelt Analysis of Tellurite Based Glass

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Abstract: This study presents an overview influence of the refractive index parameter to the parameter and radiative properties of analyticaly results on Judd Ofelt tellurite based glass, in the hope of clarifying the importance of education with good refractive index measurement. The main stages carried out is the matching between the result of the parameters and the radiative properties of analytical results on Judd Ofelt tellurite glass with composition $55TeO_2$-$2Bi_2O_3$-(40-x) ZnO-$3NA_2O$-xNd_2O_3 (x = 2.5) from a value the refractive index is estimated by the value of the refractive index obtained by measurement using Brewster angle method. The results showed that the difference in the Brewster angle ranging from 2^{o} course, will change the value of laser parameters and radiative properties Judd-Ofelt analytical results, with the exception of the Branching Ratio value. Still very much needed insight for learners to use this method. This is an example of a case where educators need to create activities that will facilitate learning well to push the conceptual change. Experiment with new variation of activities will encourage a conceptual change and the ability to analogize concept.

Keywords: Refractive Index, Judd-Ofelt, Tellurite, Glass

INTRODUCTION

Research in the field of optics-photonic today showed great enthusiasm in research-based tellurite glass. In connection with the composition of the optimum laser or *Lasic action,* tellurite glass, a material that is very promising for the application of laser and non-linear optics and new thin film technology (Prakash *et al*, 2010; Bao *et al,* 2014; Ogbuu *et al,* 2015). This glass has a good refractive index characteristics (Reben *et al*, 2010; Mallawany, 2002; Mallawany *et al*, 2008). Measurement of the refractive index itself is one part of the optical determination of the physical properties are important in addition to reflectance and absorbance. The refractive index is an important parameter to estimate the properties of the glass with a laser-Judd-Ofelt theory (Shoundararajan, 2009). The refractive index can be estimated with polarizability approach, as well as directly measured experimentally.

On the other hand, of the many concepts in physics, measurements and problems relating to the concept of the refractive index measurement is often considered as an easy and rarely found problems in students. Students generally have difficulty in respect of the concept of force and motion; the concept of wave-particle of light on modern physics; as well as the concept of the electrical and electronics (Aykutlu *et al*, 2015). Teachers generally have found that conventional methods hereditary easy enough to explain the concept of the refractive index and the density of this. As an example to explain the concept of the refractive index of the teacher is to take the light refraction or refractive event as a stepping stone to a variety of cases that are easily found in everyday life. For teachers in general sufficient experimentation using media plan parallel glass, protractor, and laser or needle to detect events of refraction. All the equation becomes deceptively simple and easy and the majority of students feel happy. It is appropriate it should be celebrated as a success. However, it must be considered in greater depth at a practical level that further influence the consequences of this habit that the physics of continuous and there are various ways and methods developed from this simple concept.

At the level of praxis measurement is not always easy. To introduce the basic concepts of this can be justified but to establish critical thinking and especially at the college level basic measurements related to these concepts must be developed with great variety. For instance, students need to be introduced that concept of reflection, refraction, and polarization related (Slabeycius *et al*, 2014). There are various tools and techniques of measurement of density, as well as the modification of Archimedes' principle (Hughes, 2006). In addition, it should be nurtured awareness that a simple measurement even if it is not done with sincerity will can lead to inaccurate measurements, which are dangerous if they become habituated. Inaccurate measuring at a magnitude even simpler, when combined analytically with other quantities in the equation to get the new scale as a finding, would produce results that are of low quality due tothe error greater than the value should be. If students have not enough knowledge regarding any variations in measurements and grow habituation to measure unacuratlely because there are too accustomed to the simple things that are not growing, it is concerned that the research that will be generated concerning the basic concept of the refractive index is not qualified.

As a concrete example of equality in the field of optics which involves further analysis parameter is the refractive index of the equation Judd-Ofelt. In this study will be presented an overview of parameters influence the refractive index of the parameter and the radiative properties of analytical results Judd Ofelt tellurite glass, so it is expected to clarify the importance of education with good refractive index measurement.

METHODS

The first stage is to determine ranges of possible values for the refractive index of a tellurite glass, tellurite glass composition used $55TeO_2$ $-2Bi_2O_3$-(40-x) ZnO-$3NA_2O$-xNd_2O_3 (x = 2.5), and by the number of ion concentration and thickness of 0.188 cm. The second stage is to measure the refractive index and the absorbance of the sample glass. Absorbance was measured using a Perkin-Elmer UV-VIS-NIR Lambda-25. Measurement of the refractive index using the Brewster angle. Figure 1 is the Brewster angle measurements set-up.

This measurement (Brewster angle methods) is quite simple, but it is a variation of the measurement technique is quite meticulous(Reddy *et al*, 2011; Thomas *et al,* 2011; Pradeesh *et al,* 2008; Lin *et al,* 2007; Nazabal *et al,* 2003). Measurement of the refractive index based on the data of reflectance on the state of transverse magnetic (TM) which has reflectance values is smallest (Brewster angle) and refractive index is obtained from the value of the tangent of the Brewster angle. How to measure the refractive index of glass is a variety of different ways those already mentioned in the introduction. The third stage is to analyze parameters Judd-Ofelt. The fourth stage is the analysis of radiative properties. The last stage is the matching between the central value (measure) parameter Judd-Ofelt and radiative properties using the input value measurement of the refractive index of the Brewster angle method parameter values Judd Ofelt and radiative properties of the input range using the possible values for the refractive index of the first stage.

Three *phenomenological* parameter Ω_2 Ω_4 Ω_6 is called Judd Ofelt intensity. These parameters can be obtained from the calculation of the power line *(line strength) S* of a transition between the initial state *(J)* and stop *(terminal) (J')* of equation 1 (Walsh, 2006).

$$S(aJ:bJ') = \sum_{t=2,4,6} \Omega_t \left|\langle aJ|U^{(t)}|bJ'\rangle\right|^2 \qquad (1)$$

In Equation 1 *a* and *b* represents *S, L,* and more specifically the quantum numbers that characterize a situation. The reduced matrix elements (reduced matrix elements) $|\langle aJ|U^t|bJ'\rangle|$ between variation of *J* of the configuration state Nd $4f^3$ invariant almost entirely related to the strength of the crystal field. After the measured line strength is obtained, this value can be used to calculate Judd Ofelt parameters. This is done by solving a number of similarities to the transition from the initial state to the final state with an equation Judd Ofelt written in Equation 2.

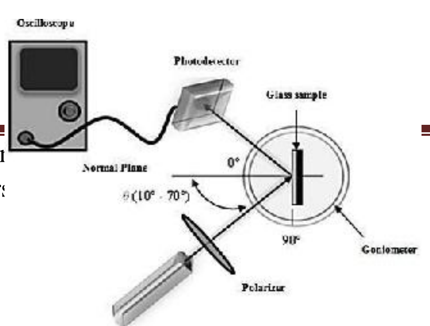

Figure 1. Brewster angle measurements Set-Up

$$f_{hitung}(J \rightarrow J') = \sum_{t=2,4,6} \Omega_t |\langle (S,L)\rangle || U^t || (S',L')J'\rangle|^2 \tag{2}$$

In Equation 2 the tensor operator unit $\langle || U^t || \rangle$ is a double reduced.

From the parameters obtained from the calculation of Judd-Ofelt, then the rate of radiative transitions and Branching ratio for electric dipole transitions from the start to the manifold end manifold can be calculated. A transition rate for this transition is given according to the equation 3 and fluorescence branching ratio *(β)* of the transition is given according to the equation 4 (Ahmad Marzuki, 2002).

$$A[(S,L)J;(S',L')J'] = \frac{64\pi^4 e^2 n}{3h(2J+1)\bar{\lambda}^3}\left(\frac{n^2+2}{9}\right)^2 \sum_t \Omega_t |\langle (S,L)\rangle || U^t || (S',L')J'\rangle|^2 \tag{3}$$

$$\beta[(S,L)J;(S',L')J'] = \frac{A[(S,L)J;(S',L')J']}{\sum_{S',L',J'} A[(S,L)J;(S',L')J']} \tag{4}$$

In Equation 4, the sum is the sum of all the possible terminal manifold. Furthermore, radiative lifetime τ_R of an excited state with regard to the total transition probabilities according to the equation 5.

$$\tau_R = \left[\sum_{S',L',J'} A[(S,L)J;(S',L')J']\right]^{-1} \tag{5}$$

RESULTS AND DISCUSSION

The range of possible values for the refractive index with glass composition $55TeO_2$-$2Bi_2$ O_3-(40-x) ZnO-$3NA_2O$-xNd_2O_3 (x=2.5), and by the number of ion concentration and thickness of 0.188 cm, is 1.9 to 2.3 (Mallawany, 2002). Results from refractive index measurements of the glass using Brewster angle method to get the value of 2.1. Figure 2 is an range that may be the estimated value of the index and the central range, which is the value of the refractive index measurement method modified Brewster angle of Burger *et. al* (Mallawany, 2002). Figure 3 is the absorbance of $55TeO_2$-$2Bi_2O_3$-(40-x)ZnO-$3NA_2O$-xNd_2O_3 glass with a wavelength corresponding to each peak.

Figure 3 is a plot of laser parameter Judd Ofelt analysis results $55TeO_2$-$2Bi_2O_3$-(40-x) ZnO-$3NA_2O$-xNd_2O_3 (x = 2.5) Glass using the input range possible values (estimate) taken a point estimate of *n* = 1.9 and 2.3 and the results of the refractive index measurement using Brewster angle *(n* = 2.1). Figure 4 is a plot of the radiative properties of the Judd Ofelt analysis results $55TeO_2$-$2Bi_2O_3$-(40-x)ZnO-$3NA_2O$-xNd_2O_3 (x = 2.5) Glass using the input range possible values (estimate) taken a point estimate of *n* = 1.9 and 2.3 and the results of the refractive index measurement using Brewster angle (*n* = 2.1).

When we let the whole measurement using Brewster angle method, then the value of the refractive index of 1.9 is obtained from the Brewster angle tangent value at $62.24^{o;}$ refractive index of 2.1 is obtained from the value of the tangent of the Brewster angle 64.54^o; and a value of 2.3 is obtained from the Brewster angle tangent value $66.50^{o.}$ This indicates that the difference in refractive index of 0.2 is the result of differences in the Brewster angle ranging from 2°. Table 1 lists the parameters of the laser and the radiative properties of Judd Ofelt analytical results 55TeO_2-2Bi_2O_3-(40-x)ZnO-3NA_2O-xNd_2O_3 (x = 2.5) Glass using the input range possible values (estimate) taken a point estimate of *n* = 1.9 and 2.3 and the results of the refractive index measurement using Brewster angle (*n* = 2.1).

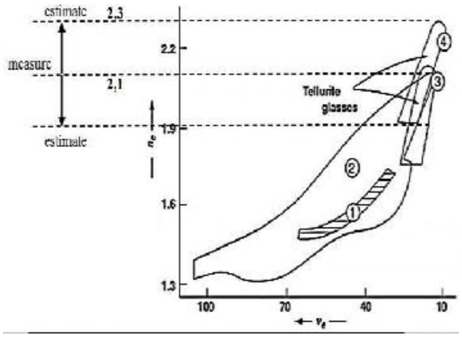

Figure 2. Regional estimate the possible value of the refractive index and the central range with the Brewster angle measurement method (modified from Burger et. al (Mallawany, 2002)).

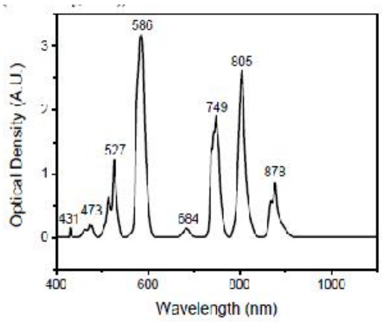

Figure 3. The absorption spectrum is formed from the glass sample 55Te_2 -2Bi_2O_3-(40-x)ZnO-3N $_2$O-xNd_2O_3 (x = 2.5)

Radiative properties of laser parameters and Judd Ofelt analytical results of 55TeO_2-2Bi_2O_3-(40-x) ZnO-3NA_2O-xNd_2O_3 (x=2.5) Glass in Table 1 and is reinforced with a plot in Figure 4 and Figure 5 shows that the difference in refractive index of 0.2 have been the result of differences in the Brewster angle ranging from 2° will change linearly approximates the shape of the laser parameter values and the radiative properties Judd-Ofelt analytical results, with the exception of the Branching Ratio value. When an error occurs refractive index measurement will have a direct impact on the value of the parameter Judd Offelt, radiative probability values, and lifetime.

The interesting thing is found to be that the value of Branching Ratio more influenced by absorbance profile than the value of the refractive index. Thus, it is still very necessary caution and thoroughness in use to measure the refractive index using Brewster angle method, although various references state that this method is quite simple. Surely this can not be achieved without activity experiment with new variations.

On learning of science (physics) changes occur when the concept of a concept changed from one category to another. All that is in this world have categories different ontologies, such as materials (objects) and processes. Status ontology from initial conception and scientific conception determines the difficulty level of learning. If two conceptions of ontology is almost the same (both material) changes to the concept will be easy. If the two concepts are very different ontologies then learning will be difficult (Chiou & Anderson, 2010). The ability of learners to analyze new problems relies heavily on trust ontology students and analysis processes. Learners have two ways of thinking when faced with a situation, which is likely to jump to a rule of thumb or intuitive conviction to make predictions. To make a satisfactory explanation, the students need to manipulate matter, and are analogous to the concept. Educators need to create activities that will facilitate learning well to push a conceptual change (Chi, 1994; Corpuz & Robello, 2011). Experiment with new variation of activities will encourage a conceptual change and the ability to analogize the concept.

Table 1. Laser Parameters and radiative properties of the $55TeO_2$-$2Bi_2O_3$-(40-x) ZnO-$3NA_2O$-xNd_2O_3 (x = 2.5) glass

Parameters		Refractive Index (n)		
		1,9 (Estimate)	2,1 (Meassure)	2,3 (Estimate)
Judd Ofelt Parameters	Ω_2 ($x10^{-20}cm^2$)	3,55	3,06	2,55
	Ω_4 ($x10^{-20}cm^2$)	1,15	0,99	0,83
	Ω_6 ($x10^{-20}cm^2$)	4,62	3,98	3,31
	Tren	$\Omega_4 < \Omega_2 < \Omega_6$	$\Omega_4 < \Omega_2 < \Omega_6$	$\Omega_4 < \Omega_2 < \Omega_6$
Radiative Probability $^4F_{3/2}$ to	$^4F_{9/2}$	856	1026	1254
	$^4F_{11/2}$	2052	2462	3007
	$^4F_{13/2}$	485	582	710
	$^4F_{15/2}$	21	25	31
Total radiative probability	A_T	3413	4095	5002
Lifetime	τ_R (μs)	293	244	200
Branching ratio	$^4F_{3/2} \rightarrow {}^4F_{9/2}$	0,251	0,251	0,251
	$^4F_{3/2} \rightarrow {}^4F_{11/2}$	0,601	0,601	0,601
	$^4F_{3/2} \rightarrow {}^4F_{13/2}$	0,142	0,142	0,142
	$^4F_{3/2} \rightarrow {}^4F_{15/2}$	0,006	0,006	0,006

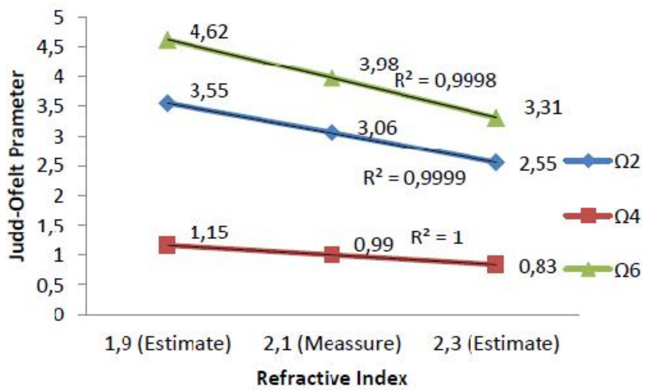

Figure 4. The laser parameter Judd Ofelt analysis results of $55TeO_2$-$2Bi_2O_3$-(40-x) ZnO-$3NA_2O$-xNd_2O_3 (x = 2.5) glass

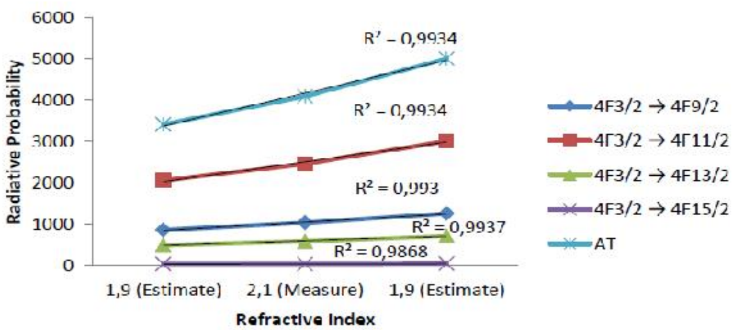

Figure 5. The radiative properties Judd Ofelt analysis of $55TeO_2$-$2Bi_2O_3$-(40-x) ZnO-$3NA_2O$-xNd_2O_3 (x = 2.5) glass

This study is an example of concrete study of conceptual change and efforts to learn concepts broadly. This is an effort to achieve a complete understanding of the concept as a whole. To uncover these things do a "coordination class" (diSessa, 1993). The steps of conceptual changes to the coordination class as implemented in this study is to provide enough analysis to find a principle; use that analysis to distinguish between concepts, create charts, find the parameters and connect it to the beginning of knowledge; The analysis followed to obtain a number of phenomena; adjust the existing data from the thinking of learners with a number of theories.

CONCLUSION

At the level of praxis measurement of physical quantities is not always as easy as it is currently studying at the elementary level. To introduce the basic concepts of this can be justified but to establish critical thinking and especially at the college level basic measurement must be developed with great variety. Experiment with new variation of activities will encourage a conceptual change and the ability to analogize the concept.

In the case of research-based tellurite optical glass, especially regarding the analysis of linear and nonlinear characteristics, the difference in refractive index of 0.2 have been the result of differences in the Brewster angle ranging from 2^{o}, will change the value of laser parameters and radiative properties Judd Ofelt analysis results, excluding in Branching Ratio value. Still it is necessary prudence and thoroughness in use to measure the refractive index using Brewster angle method, although various references state that this method is quite simple. This study is one simple example, there are many things that can be assessed on other concepts, so that innovation in learning still be needed and not interpreted must always be taught with existing activities at a higher level, but linking between the concept itself is important , do not also have a complex manner. The hope happens habituation build accuracy, concept kept still intact, and the research that produced the better.

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