

Luminescence Features of Yellow Fe₂O₃ Geruwa Mineral

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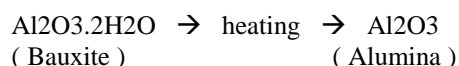
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Abstract- The chemistry of Al₂O₃.2H₂O Fe₂O₃ TiO₂.4SiO₂ mineral ore is related with finding of bauxite Al₂O₃.2H₂O, hematite Fe₂O₃ and titanium silicate TiO₂.4SiO₂ together by a loose type of bonding with each other. Thus, when the mineral is dropped in a water jar, Al₂O₃.2H₂O dissolves in water, hence increases the density of water. Fe₂O₃ due to its relatively low density remains floating in it in the molecular form. While, green sand part of titanium silicate is found to settle at the bottom of the jar due to its relatively high density. The water solution containing alumina as dissolved and Fe₂O₃ as swimming in it appears brown in colour. Al₂O₃- Fe₂O₃ attractive interactions are involved for the apparent brown colour of Fe₂O₃ molecules due to the cause of swimming of it in alumina dissolved water solution of high density. On decreasing the density of brown solution by adding excess of water, yellow tiny particles of Fe₂O₃ appear to grow in size by moving towards the bottom due to high density than of low concentrated alumina water solution now. Thus, Fe₂O₃ - Fe₂O₃ attractive interactions are responsible for the appearance of immersing yellow precipitates of Fe₂O₃ molecules in view of it's actual features of luminescence.

Keywords- Fe₂O₃, Luminescence

I. INTRODUCTION

The light which a substance emits as a result of absorption of light is called the characteristic photo luminescence of that substance. By which, absorption and emission transitions, it takes place, is a matter of spectroscopic investigations. In this presentation, the light of hematite Fe₂O₃ is concerned for studying it's yellow luminescence features. Yellow luminescence colour of Fe₂O₃ mixed with white Al₂O₃ and green TiO₂.4SiO₂ sand is distinguished from each other. These constituents exist as fragments due to brittle construction of the consisting mineral. The chemical formula of the mineral used for such investigation is already very popular and is determined as Indian yellow geruwa present in Al₂O₃.2H₂O Fe₂O₃ TiO₂ 4SiO₂. Due to absorption of water moisture by Al₂O₃ from the surrounding environment, the mineral stone gets loose structure due to its dissociation into constituents pieces by the natural course of activity. Presence of Al₂O₃.2H₂O can further be evidenced experimentally by heating the white bauxite part of mineral at a temperature of bubbling of water. Dry Al₂O₃ white powder is left as a result of evaporation of water by the following physical process [1].



II. EXPERIMENTAL

The chemical stone composed of Al₂O₃ (aluminum tri-oxide, known as bauxite), Fe₂O₃ (ferric oxide) and

TiO₂.4SiO₂ (green sand of titanium silicate) is collected from the hill area of Garhwal region of Uttarakhand state in India. When distinguished, is found white in colour due to Al₂O₃, yellow due to Fe₂O₃ and green part is due to TiO₂.4SiO₂. When such a stone comes in contact of water, it becomes very loose, therefore divides into its different constituents. Al₂O₃ reacts chemically with 2H₂O. Crystals of Al₂O₃.2H₂O are formed, hence is soluble in water.

Thus, as soon as Al₂O₃.2H₂O Fe₂O₃ TiO₂.4SiO₂ rock stone powder is dropped into water jar tank, the bauxite itself comes out of the rock stone and gets dissolving in water. The density of water is so increased which depends upon the amount of alumina dissolved in it. The density of the water solution desirably attains such a value that TiO₂.4SiO₂ is totally unable to float in it. It is settled at the bottom due to it's high density than of alumina dissolved water solution. After settlement, it is seen that the remaining solution is brown in colour. It is decided that TiO₂.4SiO₂ is more heavier than Fe₂O₃, hence is settled at the bottom of the container. Fe₂O₃ on the other way, due to it's less density, goes on floating molecularly and homogeneously in the form of brown solution. Such a brown solution which is free from sand part is removed from the container into another. The red (brown) solution is now taken only for further investigations.

The density of alumina dissolved water solution floating Fe₂O₃ is now decreased by adding excess simple water in it. The solution becomes yellowing. Fe₂O₃ precipitates and begins to sit at the bottom. As the brown solution is diluted, it's concentration goes on decreasing. The density of diluted solution is decreased. Fe₂O₃ present in the

solution, due to its high density than of diluted solution is now unable to float. Particles of Fe_2O_3 - Fe_2O_3 are interacted in bulk. Yellow precipitates are observed to appear to go downwards together at the bottom of the container. Transparent alumina solution which is left behind is removed from the upper side of the container. While, Fe_2O_3 from the bottom of jar is separated for further related investigations.

III. RESULTS AND DISCUSSION

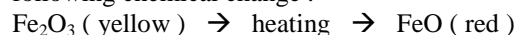
In Alumina (Al_2O_3) and Hematite (Fe_2O_3) associated brown solution, when Fe_2O_3 remains swimming in alumina dissolved highly concentrated solution, the density of the solution remains increased and the colour of the solution becomes mainly brown. The molecular interactions take part to explain the cause. It seems that high concentration of alumina not only helps to float Fe_2O_3 but also interact with Fe_2O_3 , hence causes red brown solution of Fe_2O_3 instead of yellow Fe_2O_3 itself. At this state of solution, Fe_2O_3 - Fe_2O_3 forces are cohesive but not effective while Al_2O_3 - Fe_2O_3 forces are adhesive but interactive. In the brown solution, Al_2O_3 - Fe_2O_3 adhesive force remains interactive. As a result, a lot of Fe_2O_3 remains swimming along with Al_2O_3 in water due to swimming interactions.

In the brown solution, the luminescence band of Fe_2O_3 is approximately the same as that of FeO (red) molecules. Hence, in Al_2O_3 dissolved water solution, the fluorescence of floating Fe_2O_3 is similar to that of FeO . The luminescence of Fe_2O_3 in Al_2O_3 dissolved water solution can be said to have changed by the phonon assistance of surrounding host lattice [2]. Thermal quenching of FeO red light into brown is also a part of this investigation which also supports the role of phonons during de-excitation processes. If the density of brown solution is lowered, the distance between Al_2O_3 - Fe_2O_3 and Fe_2O_3 - Fe_2O_3 both will increase, as a result of it, the nature of intramolecular forces will also change. The adhesive force between Al_2O_3 - Fe_2O_3 disappears and cohesive force between Fe_2O_3 - Fe_2O_3 appears dominant as attractive.

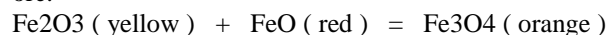
Thus, on decreasing the density of brown solution when the distance between Fe_2O_3 - Fe_2O_3 molecules is moderate, the attractive interactions involved are dominant to carry the tiny yellow particles of Fe_2O_3 to grow in size. At this time, tiny particles free from interaction with the solution go downwards due to high density than of the solution. The fluorescence light is yellow due to Fe_2O_3 - Fe_2O_3 interaction. This light is its original actual characteristic light. Yellow particles go downwards due to gravity and growing in size. More and more particles now come in the range of interaction with Fe_2O_3 others. Finally precipitates of Fe_2O_3 are settled at the bottom of the jar. The luminescence of downward going Fe_2O_3 is not affected by the presence of Al_2O_3 surrounding solution because Fe_2O_3 particles are seen to be yellow in colour. In this way Fe_2O_3 can be separated as yellow powder spectroscopically. Thus, Archimedes law of

swimming is found to be very helpful to extract pure Fe_2O_3 and to understand the mechanism of floating bodies and the interactions involved with the fluid.

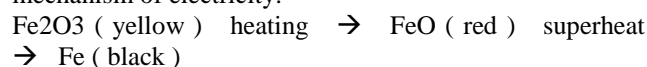
During the isolation of substitutes of mineral, some important and remarkable observations are noticed regarding the luminescence features. Firstly, it is seen that the colour of iron oxides differ in colour due to its chemical composition. If yellow ferric oxide Fe_2O_3 powder is heated, it turns into red ferrous oxide FeO by the following chemical change .



It means red iron oxide is FeO which emits its characteristic red light. This is also known as Indian red geruwa. It is also seen that during the heating of Fe_2O_3 and partial transformation of it into FeO , both the oxides resulted a following type of colour mixed compound known as Fe_3O_4 , which on super heating changes into brown colour and finally into Fe black. Due to its ferro magnetic property, it is familiarly known as magnetite iron ore.



Fe chips can also be easily fabricated by heating iron utensil containing Fe_3O_4 at red hot temperature. The chips are separated with the help of sodium bicarbonate paste spread over the chips formed. Iron coated chips so fabricated are used to obtain sparking white light of Fe in the atomic state and also to trace the path of short circuit mechanism of electricity.



Thus, the white light of Fe obtained by electrical sparking when analyzed in view of atomic line spectroscopy is found entirely different from the molecular spectroscopic light arising due to presence of dis-similarity of Fe-O bond both in Fe_2O_3 and FeO molecules. Because the molecular light of Fe_2O_3 is yellow while that of FeO is red.

LUMINESCENCE FEATURES OF STUDY

It is also a point of observation that the red fluorescence light of FeO quenches on moderate heating and regains its red light on cooling. This happens due to the concept of role of phonons on relaxation process [3]. The phonons are actually associated with the lattice by its energy as the existing vibrational energy related with stretching frequency of Fe-O bond present in this case of investigation. The radiative emission transitions by which red light of Fe is emitted by FeO molecule occur at room temperature only. As the temperature is increased, the energy of phonon concerned with the lattice is increased. The increase of energy of phonon does not allow electron to go for radiative transition while returning towards lower initial ground state. A part of kinetic energy gained by the down going electron due to acceleration by electrostatic force is lost successively in various steps during relaxation by dissipation to the phonons of the lattice. While, the other part of kinetic energy remains with the electron still

accelerated during the motion until the electron is finally relaxed to its lower orbit for going to revolve.

In order to know the luminescence features of Fe₂O₃, spectroscopic atomic light of Fe is compared with the molecular light of yellow Fe₂O₃ and red FeO. Because, Fe is common in all. This difference of light can be explained on the basis of spectroscopy of iron in different environments. The change in colour exhibits a clear picture that there is a difference in structural bonding. High energetic yellow light is emitted by Fe₂O₃. But in case of FeO it's light is only low energetic red light. The luminescence of iron is therefore phonon assisted both in Fe₂O₃ and FeO. Two different types of phonons are associated with two different types of compounds due to dis-similarity of FeO bond stretching frequency present in each of the compound. This difference of light is also compared with respect to the continuous light emitted by Fe atom in the absence of any bond. The atomic light of Fe is obtained by sparking method generated due to short circuit mechanism of electricity. This line spectrum of Fe is widely spread over in a region of wave length of light from ultraviolet to infrared including the visible white also. The band spectra of FeO and Fe₂O₃ light are mainly confined up to wave length band of visible red and yellow photons of light. Because, the wave length of yellow light emitted by Fe₂O₃ is less than the wave length of red light of FeO. Hence, the phonon energy in yellow Fe₂O₃ will be different than the phonon energy of red FeO due to structural bonding between constituents responsible for the formation of bond energy.

IV. CONCLUSION

In regard to this presented investigation, the main aim of the study is focused to isolate the three main constituents of the material used. White alumina powder is extracted by drying transparent alumina dissolved water solution. Green sand part is isolated in water due to its very high density. Fe₂O₃ is almost purified by a concept of spectroscopic view due to formation of tiny particles of Fe₂O₃ and its yellow fluorescence emission as a result of absorption of sun light. On heating Fe₂O₃, It's structural change is very important to find the change in its colour with temperature because when it becomes black, it is known as magnetite ore due the formation of a ferromagnetic substance.

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