a WOW Lab BLUEPRINT

Quanta of Colour

Additional Information

Exploring Fluorescence

Fluorescence is a chemical phenomenon where electrons are excited from the ground state, and during the relaxation to the ground state, release energy in the form of electromagnetic radiation as light. This process can be visualized with a Jablonski diagram (**Figure 1**). The black lines are energy levels for the ground and excited states of the electrons. The purple line shows the path the electron takes when excited by the ultraviolet light. In this case, it goes beyond the excited state, thus undergoing a non-radiative relaxation to the excited state. Non-radiative means that it does not produce light. Once the electron is in the excited state, it can relax through either radiative or non-radiative means. The more frequently electrons follow the radiative path, the more prominent the fluorescence.

The wavelength of the light emitted is dependent on the energy gap between the two energy levels. These levels depend on various properties of the atom or molecule in question. For quantum dots, there are various properties that determine the energy gap. Size is one of these variables; as it can be controlled, it is exploited in this experiment. The larger the quantum dot, the smaller the energy gap, and thus, the lower energy (longer wavelength) of light emitted.

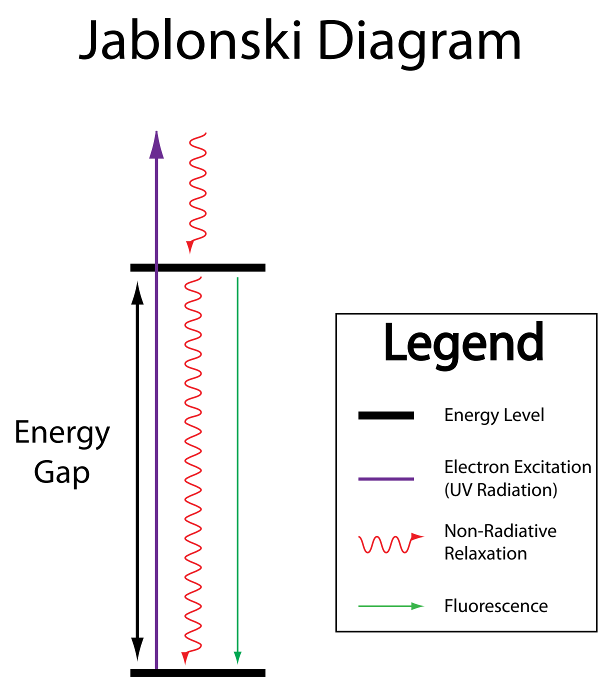

Figure 1

Reaction Kinetics

While there are numerous factors that affect the rate of a chemical reaction, temperature is the one explored in this particular demonstration. **Figure 2** shows the energy of a chemical system as a reaction progresses. A is the initial energy, B is the energy level required for the reaction to take place and C is the final energy. The distance between A and C is the amount of energy that is released from the reaction. The distance between A and B is the activation energy, which is the energy required to start the reaction. The reactants overcome the activation energy when they collide with each other or receive energy from external sources such as light. In this case, it is primarily collisions that cause the increases in energy.

While the energy required to start the reaction is fairly constant, the initial energy of the system can vary, particularly with temperature. As temperature increases, the energy of the system increases, resulting in a lower activation energy; this in turn speeds up the reaction. This principle is demonstrated in this experiment by heating one of the solutions to 60-65 °C.

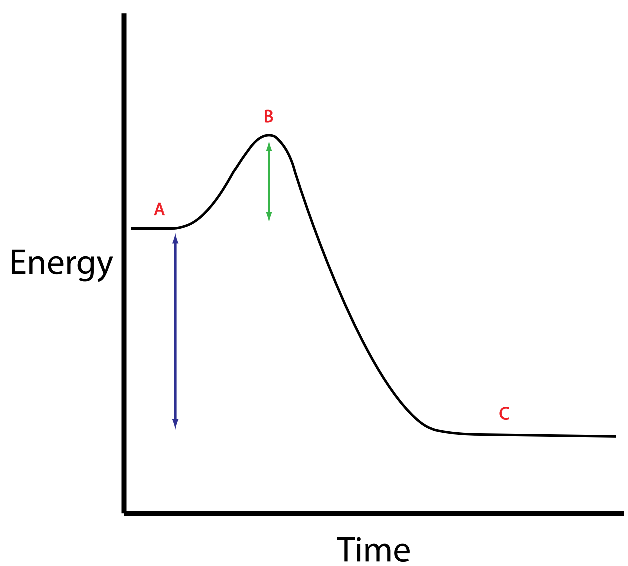

Figure 2

Self-Assembly

Self-assembly is a chemical process where the materials spontaneously react to produce an organized structure that grows for as long as the required materials are present. The process of crystallization is a good example of this process. Like all reactions, there are several factors that affect the speed at which the reaction takes place. The speed of the chemical reaction is called the rate constant. In this demonstration, temperature is used to accelerate one of the reactions.

The specific reaction used in this activity is shown in **figure 3**:

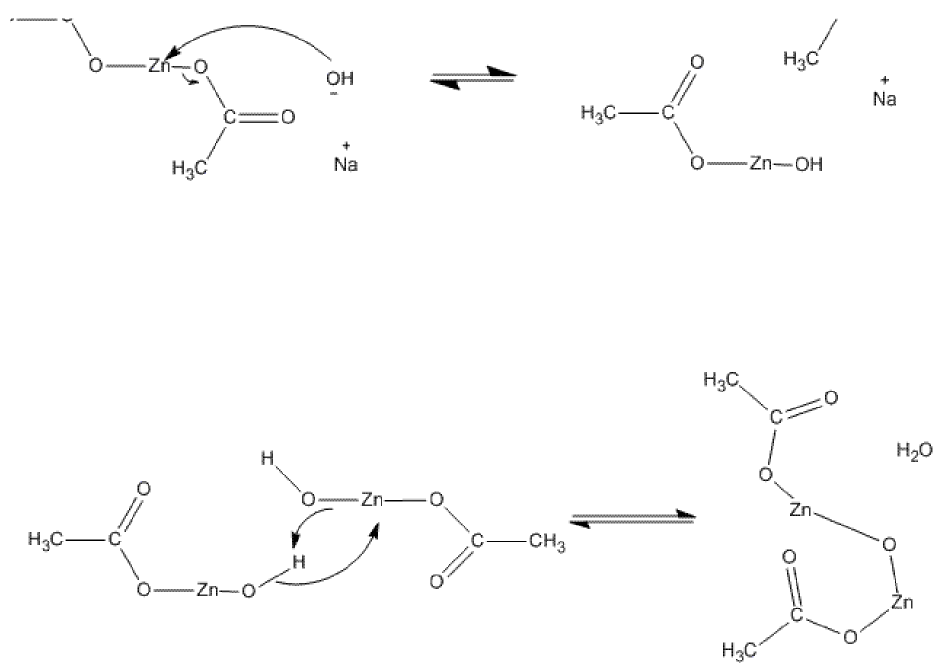

Figure 3

This process repeats to produce an ever growing zinc oxide lattice structure.