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Potassium Chlorate Decomposition Under High Pressure

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Background

High pressure physics involves placing various substances under high pressure and observing changes in that substance. In this experiment this high amount of pressure is induced using a diamond anvil cell. A diamond anvil cell uses a metal gasket to hold the sample between two diamonds, which will press on the sample to reach high pressures. High pressures are reached with a moderate amount of force by exerting that force over a small area. Diamonds are used for the compression because of their hardness and ability to resist compression.

The pressure being exerted on the sample using a diamond anvil cell is often measured using ruby fluorescence. The behavior of ruby under high pressure is well known so the pressure inside the diamond anvil cell can be determined by observing the ruby fluorescence. Ruby is placed inside the gasket along with the sample so that it is always at the same pressure as the sample.

Potassium Chlorate is a chemical that is often used as an oxygen producer and as an explosive when mixed with other chemicals. It decomposes under heat to release oxygen gas, which is the reaction we are trying to induce by placing the chemical under pressure. When molecules heat up they begin to vibrate more rapidly and are more likely to collide with each other. When molecules undergo pressures they are also more likely to collide as atoms get closer together. The purpose of this experiment is to determine if pressure can induce the same reaction in Potassium Chlorate as heat.

Experiment

Raman spectroscopy was the method used to analyze the sample under pressure. Before this analysis took place the samples of manganese dioxide and potassium chlorate were ground into fine powders using a mortar and pestle. A diamond anvil cell was set up with a 3 to 1 ratio of potassium chlorate to manganese dioxide by mass. Small pieces of ruby were also placed inside the cell. This diamond anvil cell was then pressurized to 15.66 GPa. The microraman system was used on multiple parts of the sample.

Adding a higher temperature was the next step in analyzing the sample. An oven was used to heat the cell containing the sample to 50°C. The sample was left at this temperature for 10 minutes and then allowed to return to room temperature. The raman system was then used on the sample to see if any change occurred. In the future the same procedure will be performed at higher pressures and possibly higher temperatures. After analyzing higher pressures and temperatures the cell will be opened up and then raman spectroscopy will be performed on it again.

Analysis

After the experiment was performed, the analysis involved watching for possible peaks. Specific wavenumbers were watched where previous experimenters have found peaks representing certain bond types. A peak around the wavenumber of 1556 cm⁻¹ was expected if oxygen gas was present in the cell. This peak would indicate that a reaction had taken place. This peak was not noticed in either of the sets of data collected.

With the data from the experiment it appears to our knowledge that a decomposition reaction has not occurred. In the future when more pressures and temperatures are tested it will be easier to determine when the potassium chlorate will decompose if at all. After higher pressures are tested, the cell will be opened up so that any gas that was created will exit the cell. The sample will then be tested again to determine if any peaks disappeared. If a peak disappears then it is likely that a gas was created and then exited the cell when the cell was opened.

References


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