A change in the temperature or a transformation of the phase of a material requires an exchange of heat with the surroundings. This exchange of heat can be used to store thermal energy. Currently, the storage of thermal energy is used to increase the efficiency of heating and cooling of buildings. In the future, storage of thermal energy may play an important role in enhancing the feasibility of systems that convert solar thermal energy to electrical power.

The heat capacity of a solid material is mostly determined by the thermal excitations of lattice vibrations. In the classical limit, i.e., when quantum effects are negligible, the specific heat per mole is approximately 3R, where R is the gas constant,$R= N_A k_B$. Therefore, if quantum effects are not too important, the heat capacity per unit volume is maximized at large atomic densities. Einstein's model for the specific heat of solids takes into account quantum effects. In Einstein's model, the entire spectrum of lattice vibrations is replaced by a ensemble of harmonic oscillators; all of the oscillators have the same frequency. This so-called "Einstein frequency" can be determined from the temperature dependence of the heat capacity.

Transformations of single-component material typically occur at constant temperature. For example, ice transforms to water at a constant temperature of 0 °C. The heat required to produce the transformation is called the latent heat. For a transformation at constant pressure, the latent heat is equal to the change in enthalpy or, equivalently, the change in entropy divided by the temperature of the transformation. A transformation between a crystalline phase and liquid typically has a change in entropy per mole that is on the order of R. Therefore, the latent heat per mole is typically on the order of RT_c, where T_c is the temperature of the transformation.

Differential scanning calorimetry (DSC) provides a convenient and rapid method of measuring heat capacities and latent heats. In a DSC, the sample and a reference are heated separately; the heating power applied to the sample and the reference is controlled to produce a constant rate of change of temperature. The difference in the heating powers applied to the sample and reference is a measure of the heat capacity and the latent heat of any transformations of the sample.

In this experiment, we used the temperature dependence of the heat capacities to determine the Einstein temperatures of graphite and SiC. We compared the latent heats of melting and crystallization of an element, Bi, with the latent heats of molecular crystals, stearic acid and n-alkanes.