

## Why impure solids melt at lower temperatures

A melting point is a characteristic physical property of a substance. Melting point analysis is one of the simplest and most useful techniques for the identification of a chemical substance. Melting point analysis can also provide information about the purity of a sample. A substance (solid) containing impurities usually melts at a lower temperature than the pure compound, and melts over a wide range of temperatures. This is called the "melting point depression". In general, the smaller the range of melting temperatures, the higher the purity of the sample.

Most of the solids we encounter in the laboratory, organic or inorganic, are crystalline solids. These have molecules (for solids like caffeine) or repeating clusters of ions (for solids like  $\text{CuSO}_4$ ) arranged in a regular, tightly packed repeating crystal lattice. The lattice is held together by various intermolecular forces, which come about because of the chemical nature of the solid. These forces must be disrupted when a substance melts, which requires an input of energy. This in turn translates to an elevated temperature. Thus, the stronger the forces that hold together a solid, the higher its melting point. It is not difficult to understand how impurities affect the melting point. Foreign substances in a crystalline solid disrupt the repeating pattern of forces that holds the solid together. Therefore, a smaller amount of energy is required to melt the part of the solid surrounding the impurity. This explains the melting point depression (lowering) observed from impure solids. The more impure the solid is, the more its structure is disrupted, and the greater the variation in intermolecular forces in different areas of the solid. The effect: the melting temperature is lowered compared to the pure solid, and the solid melts over a wider range of temperatures.