Melting Behaviour of Triblock Polymers (Poloxamers) in Supercritical CO₂

Vivek Trivedi, Ruchir Bhomia, Nichola Coleman, John Mitchell
School of Science, University of Greenwich, Central Avenue, Chatham Maritime, ME4 4TB, UK

Carbon dioxide (CO₂) is the most commonly used SCF because of the relatively mild operating conditions (31.1°C and 72.8 bar) and easily tuneable properties. Moreover, the ability of CO₂ to act as a solvent and solute has made it highly desirable in the field of excipient processing, particle formation and drug encapsulation. The dissolution of CO₂ is known to affect glass transition or melting temperature of polymers and fats [1]. In this work, the effect of the dissolution of liquid (l.CO₂) or supercritical (sc. CO₂) was studied on the melting point of various poloxamers (Pluronic™ F77, F127, F38, F68, F108) at the pressure ranging from 70 to 250 bar in a supercritical phase monitor. The treated and untreated samples were analysed by X-ray diffraction (XRD), scanning electron microscopy (SEM) and differential scanning calorimetry (DSC).

The melting point depression between 14.6 °C to 19.3 °C was observed for poloxamers studied in this work. This decrease was dependent on the polyethylene content and the molecular weight of the polymer, where the trend in melting point depression was found to be F77 > F127 > F38 > F68 > F108. This phenomenon can be explained by the solubility behavior of CO₂ in the polymeric matrix. Here, CO₂ acts as a plasticizer which increases the free volume in the excipient by penetrating into the inter-molecular spaces and hence decreases the melting point substantially. The operating pressure was also an important factor. For all polymers; the melting point decreased rapidly before reaching to a minimum value with the increase in pressure. The comparison of DSC, SEM and XRD results of CO₂ treated and untreated samples showed no morphological changes in poloxamers due to sc. CO₂ treatment.

In conclusion, poloxamers showed a significant depression in melting temperatures in sc. CO₂ and analysis of treated and untreated samples confirmed that no morphological changes were made due to SCF processing at studied parameters. This approach can be used for the particle design and coating of thermo labile substances and biologics at considerably low temperatures.


Key words: Supercritical CO2. Melting. Triblock polymer. Poloxamers