Surface Properties of Milled and Unmilled Form I Paracetamol Powders

Daryl R. Williams, Jerry Y. Y. Heng

Department of Chemical Engineering and Chemical Technology, Imperial College London, South Kensington Campus, London SW7 2AZ, United Kingdom.

The surface properties of materials are of both fundamental and practical importance in the performance of particulate materials such as pharmaceutical and fine chemicals [1]. In this study, the differences in habit due to crystallisation solvents and effects of milling and particle size of form I paracetamol powders have been investigated. These differences in material surface properties were characterised by determining their surface energy using Inverse Gas Chromatography (IGC). The surface energies obtained were compared with those calculated from sessile drop contact angle measurements on macroscopic single crystals [2].

Fine paracetamol crystals were obtained by cooling saturated solutions of methanol and acetone from 30 ^{o}C to room temperatures, resulting in crystals of differing habits. In addition, macroscopic (>2cm) single crystals were grown by slow solvent evaporation at 20 ^{o}C over a period of 20 days from saturated solutions of methanol and acetone. These macroscopic crystals were ball milled. The fine crystals (unmilled) and milled materials were sieved into different particle size fractions, ranging from 32μm - 600μm.

The dispersive surface energies, γ_s^d for both sets of milled sample increased up to 40 mJ/m^2 with decreasing particle size. The γ_s^d were found to be independent of habit of the macroscopic crystal. The surface acidity numbers, K_A were found to be constant by a decrease in basicity numbers, K_B of milled materials as particle size was reduced was observed. For the unmilled materials, the K_B was comparable to the K_A but with a significantly lower γ_s^d of only 30 mJ/m^2 [3]. Milling resulted in fracture along crystal's lowest attachment energy plane [010], exposing facets of different surface chemistry to that of the native external facets. Contact angle measurements on the [010] fracture plane [4] of a macroscopic crystal also confirmed higher γ_s^d compared to the external facets of the single crystals. The differences in both γ_s^d and acid-base properties are attributed to differences in local surface chemistry in terms of presence of functional end groups, their orientation and densities on each facet.

The effect of milling is to expose a hydrophobic surface for paracetamol form I crystals and this effect becomes increasingly more dominant with decreasing particle size. IGC is shown to be highly sensitive in detecting the effect of milling as well as the dependence of surface energies on particle size.

References

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