Our main research focus is in the application of advanced surface analytical technologies for the exploration of the physical and chemical factors which govern particulate interactions in pharmaceutical dosage forms. We are also focussed on the development of novel particle engineering technologies for pharmaceutical systems.

Particulate Interactions in Inhalation Systems

The characteristic properties of dry powder and suspension based pressurised metered dose inhaler formulations are governed by a fine balance of the cohesive (drug-drug) and adhesive (drug-excipient, drug-device) interactions. Our research interests involve characterising the relationship between short-range and long-range interfacial forces with aerosol behaviour. The refinement of the colloidal probe AFM technique, led by the pharmaceutical surface science research group, has provided a novel preformulation tool for characterising the physico-chemical properties of active pharmaceutical ingredients within solid-state formulation preparations and a means of determining the key attributes which control and enhance their behaviour (Figure 1).

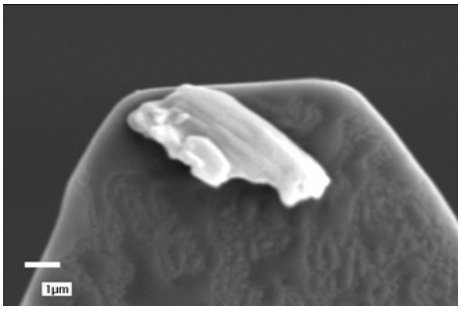

Figure 1: A colloid drug probe

Surface Stability of processed particles

The uncontrollable nature of secondary processing (e.g. micronisation, milling) of active pharmaceutical ingredients has been shown to lead to significant *inter* and *intra* batch variations in formulation performance and the potential source of instability within powder based formulations. The shear forces applied inevitably lead to localised formation of amorphous disorder on the surfaces of the particles. Although the concentration may be low, for high surface area to volume particles it may significantly affect their physico-chemical properties.

To investigate their possible effects we have utilised the AFM in its conventional imaging mode together with an auxiliary phase imaging technique to elucidate variations in the physico-mechanical properties of mechanical processed particles. This novel approach has provided direct characterisation of surface induced disorder of processed particle and real-time visualisation of the surface stability induced by variations in temperature and/or moisture (see Figure 2).

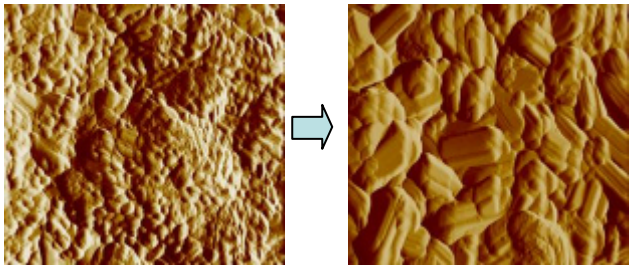

Figure 2: Moisture induced surface recrystallisation of a micronised particle

Particle Engineering Processing

Although constructive processes for the production of solid drug particles within an optimum particle size range are available, there remains a need to develop novel particle engineering technologies with a greater control of the physico-chemical properties while maintaining high throughput, low cost and industrial scalability. Our approach has utilised the information available at the single particle level to develop several novel technologies in the area of particle engineering. This includes the novel production of spherical crystalline particles through a combination of solution atomisation and controlled crystallisation by ultrasonication (SACS). The SACS process has been utilised as a single step (continuous or batch) operation which can control and modify the size, shape, while influencing the surface roughness and polymorphic form of drug crystals in a single droplet to particle (SDP) operation (see Figure 3).

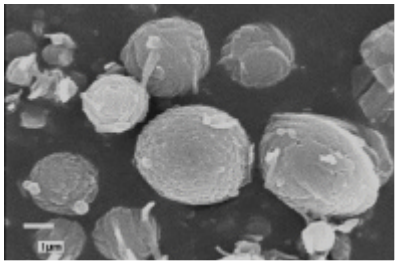

Figure 3: Spherical crystalline particles engineered via SACS

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