Tribological study of the factors influencing the mechanisms of abrasion involved in removing a thin film from a stainless steel surface

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The formation of fouling deposits on surfaces is a problem that affects most people on a daily basis. As well as being a key part of life in the work place and home, "cleaning science" can form a critical part of the food, personal care, medical, hospitality, electronics industries, amongst others [1-3]. To remove the different types of soils that can form and grow on surfaces, many cleaning processes have been developed. They are based on either a physical or chemical action, or a combination of mechanisms including, for example, chemical reaction, plasticisation, emulsification, ploughing, and roll-up. The main aim of most cleaning products and processes is to maximise the removal of the fouling deposit whilst minimising the damage to the underlying surface.

The current project is focused on one particular type of cleaning process, that of liquid abrasive cleaning (LAC), and understanding the fundamental science underpinning LAC processes. Abrasive fluids are used for cleaning teeth and tough household soils, in which chemical cleaning is difficult either because the soil is too inert or the use of chemicals required is too hazardous or produces other undesired affects [4]. The reason for avoiding the use of abrasives in all cleaners is due to the inherent potential of causing damage to the all underlying surface [5]. Despite a long history, there is a lack of understanding of the fundamental science of abrasion associated with LAC fluids.

The current investigation is focussed on indentifying and quantifying the cleaning properties of various model formulations acting on a baked dehydrated castor oil deposit formed on stainless steel. Investigations have been carried out using a reciprocating linear tribometer to produce wear and measure the friction. The dehydrated castor oil soils, worn by the fluids on the tribometer, were then analysed using gravimetric, laser profilometeric and microscopic techniques.

In the first part of this investigation, experiments were conducted with a model surfactant solution. Wear mechanism were found to differ as a function of baking time, sliding speed and normal load. A change in the wear mechanism contributes to a quantitative difference in the rate of soil removal. These results are consistent with expectations based on previous results in the literature, validating the experimental procedure.

Work is now being conducted on to determine the relative importance of the various factors that govern the performance of an abrasive cleaning formulation based on a structured surfactant system. Ultimately the aim is to use a series of simple fluid systems in order to better understand and interpret the behaviour of more complex surfactant systems e.g. with different mesophases.

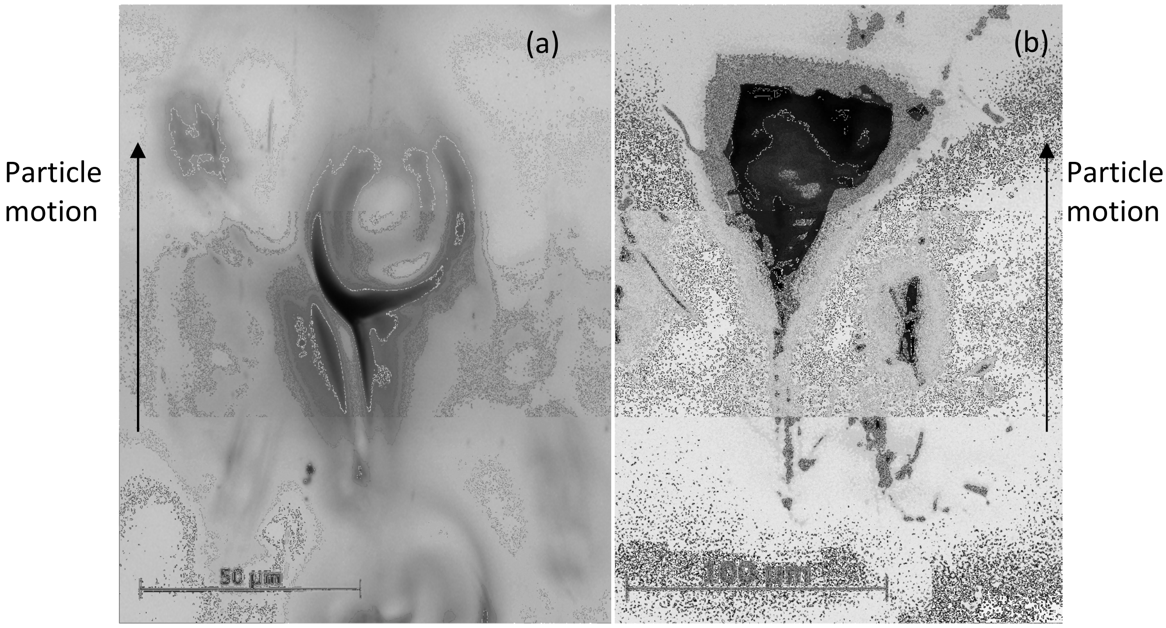

Figure 1: Typical wear patterns produced on a dehydrated castor oil deposit. The soil was worn by a 12.7mm spherically capped probe in the presence of a suspension of abrasive particles. These are optical images of wear tracks corresponding to a sliding velocity of 15.2mm/s and normal loads of (a) 10 g and (b) 50 g. (a) the deformation is consistent with repeated "cutting" into the surface that results in a build up of pressure under and in front of the particle eventually resulting in a branched crack at the rear of the contact. Subsequently, the particle jumps to a new contact location before delamination of the oil deposit can occur. (b) Larger cracks in the soil have been propagated and fragments have detached from the surface indicating that more severe wear has occurred [6-9]. The images suggest that the response is more brittle under the greater normal load.

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