MATCHING THE NANO- TO THE MESO-SCALE: EXPERIMENTS WITH ATMIC FORCE MICROSCOPY AND MICROMANIPULATION

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ABSTRACT

Many researchers have studied the effects of changing the surface on fouling and cleaning. In biofouling the 'Baier curve' is a well-known result which relates adhesion to surface energy, and papers on the effect of changing surface energy to food fouling can be found more than 40 years ago. Recently the use of modified surfaces, at least at a research level, has been widespread. The problems in developing such a surface are substantial; the surface has to be effective and long-lasting, as well as being cheap enough to make extended surfaces out of.

In this work two different ways of studying surface-deposit interactions have been compared. Atomic force microscopy (AFM) is a method for probing interactions at a molecular level, and can measure (for example) the interaction between substrate and surfaces at a nm-scale. At a μm-mm level, we have developed a micromanipulation tool that can measure the force required to remove the deposit; the measure incorporates both surface and bulk deformation effects.

The two methods have been compared by studying the interaction between a range of model soil:; toothpaste, as an example of a soil that can be removed fluid mechanically, and confectionary soils. Removal has been studied from glass, stainless steel and PTFE surfaces as examples of the sort of surfaces that can be found in practice. AFM measurements were made by using functionalized tips in force mode. The data show that the two types of probe give similar results, although the rheology of the soil affects the measurement from the micromanipulation probe under some circumstances. The data suggests that either method could be used to test candidate surfaces for whether they can aid removal.

Further experiments have studied the temperature dependence of the AFM adhesion forces. Adhesion occurs at high temperature (such as those above 80ºC found in milk pasteurisers), but for milk proteins the adhesive force decreases with temperature – the reaction rate, rather than changes in adhesion, must control fouling.