

Quantitative DPI Studies of Fabric Care Formulation Behaviour using Cellulose AnaChip™

Introduction

Dual Polarisation Interferometry (DPI) is a major enabling tool for surface scientists and has proved invaluable in the research and development of a range of household and personal care products within FMCG industries. Farfield's **AnaLight**® DPI instrument series embodies a quantitative analytical technique, providing absolute mass, dimensional and refractive index (density) measurements of 'soft' surfaces ⁽¹⁾.

This application note describes the use of the Cellulose **AnaChip**™ (*Farfield part no: 2007-211c*) as a viable mimic for cotton in the development of fabric care products. The experiments focus on the structural and behavioural measurements derived from the interactions of the cellulose **AnaChip**™ surface with products designed for use in the fabric care industry. Changes in the physical parameters of the cellulose surface caused in response to typical fabric wash liquor and conditioning formulations are measured. These changes can be directly related to the structure and behaviour of the molecular components of the formulations at the cellulose (cotton) surface. This enables the mechanisms and complex interactions of multi-component formulations to be studied in the context of the model cotton surface, cellulose.

Results and Discussion

Model cotton surface behaviour on exposure to typical fabric care product formulations:

An uncharged polymer known to bind to cellulose was deposited on the cellulose **AnaChip**™ surface. **Figure 1** shows the adsorption behaviour of the polymer to the cellulose chip (**AnaLight**® instrument fluidic channel 1 only) followed by a wash liquor and conditioner challenge. The wash liquor does displace some of the polymer, the mass reduces post-wash, and the conditioner can be seen to coat the polymer (small thickness increase), which stabilises the layer.

The control channel (**AnaLight**® instrument fluidic channel 3 only) is subjected to the same series of challenges but *without* the initial polymer adsorption (**Figure 2**). The challenges are typical liquid fabric wash formulations containing surfactants and salts (the polymer used would normally be a component of this type of formulation).

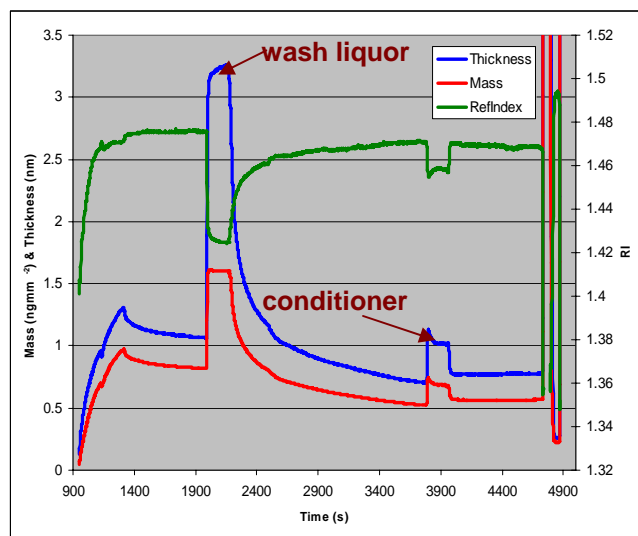


Figure 1: Adsorption of uncharged, cellulose-binding polymer on Cellulose AnaChip™ followed by addition of fabric wash liquor, fabric conditioner and finally 80% ethanol (AnaLight**® Channel 1)**

The adsorption behaviour of the wash liquor surfactant can be measured, as can surfactant rinse-off behaviour on returning to water at the end of the sample addition. In **Figure 2**, without polymer, the decay due to surfactant rinse off is stopped by addition of conditioner, the most likely explanation being that the surfactant is replaced by conditioner. The layer is much thinner than in the presence of polymer (**Figure 1**); measuring 0.3nm as opposed to 0.8nm.

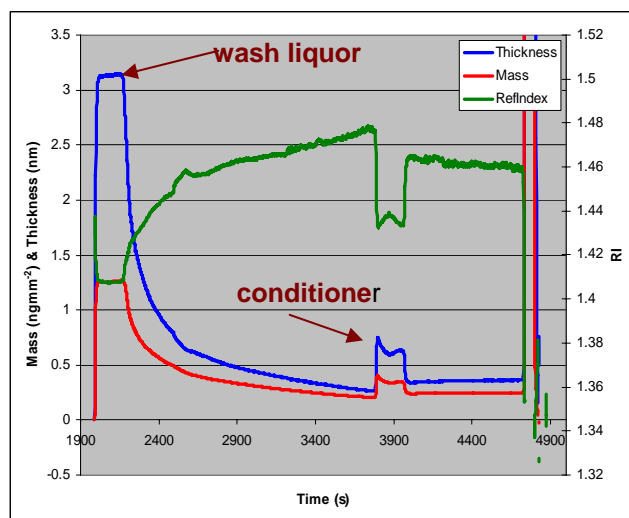


Figure 2: Adsorption and rinse off of fabric wash liquor, fabric conditioner and finally 80% ethanol on Cellulose AnaChip™ (AnaLight**® Channel 3)**

The ethanol addition at the end of the experimental series removes all fabric wash liquor and fabric conditioner, returning the **AnaChip™** surface to native cellulose (**Figure 2**), in contrast to the polymer surface (**Figure 1**) which retains its pre-conditioner coated polymer structure (see **Figure 3**)

Figure 3 contrasts the rinse-off characteristics between the two **AnaLight®** fluidic channels from the experiments above (i.e. channel 1 presence and channel 3 absence of polymer). Following addition of the liquid wash formulation and subsequent rinsing, a concentrated fabric conditioner solution is added to the cellulose surface. This results in an increase in the adsorbed mass, a decrease in the density of the layer on the cellulose surface and the stabilisation of the decay of surfactant from solution.

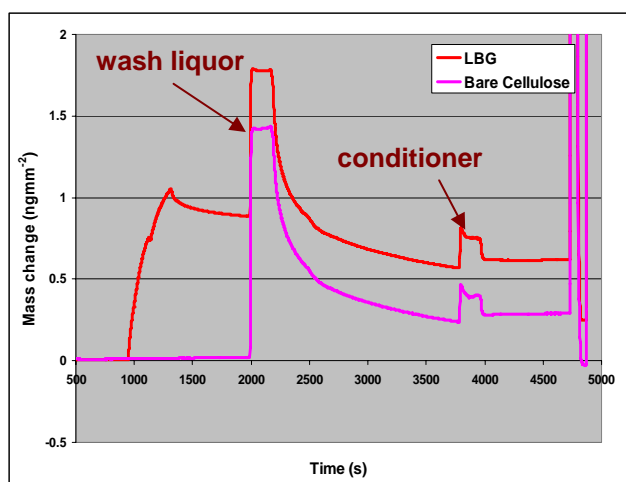


Figure 3: Contrasting mass changes (presence and absence of polymer) during adsorption and rinse off of fabric wash liquor, addition of fabric conditioner and finally 80% ethanol on Cellulose AnaChip™

Data in **Figure 3** demonstrates that the molecular mode of action of the fabric conditioner formulation is to displace the residual surfactant from the surface and form a stable adlayer on the cellulose-polymer surface. The displacement can also be observed during the conditioner addition itself. At the end of the experiment 80% ethanol was injected, which removed the conditioner returning the cellulose surface to its original state on the control channel

References:

1. GH Cross, A Reeves, S Brand, MJ Swann, LL Peel, NJ Freeman & JR Lu *J. Phys. D: Appl. Phys* **37** 74-80 (2004)

(channel 3), but not displacing the polymer from the experimental channel (channel 1).

Conclusions and Benefits

These experiments clearly demonstrate the viability of the Cellulose **AnaChip™** as a mimic for cotton surfaces in fabric care applications. **AnaLight®** DPI measurements reveal structural and behavioural details of the interactions between this cotton mimic and surfactants, liquid fabric wash formulations and fabric conditioner formulations.

The **AnaLight®** instruments and their experimental protocols give fabric care R&D, and the wider FMCG industries, unique molecular-scale measurements in real time on the interaction behaviour between industrially-relevant surfaces and product formulations. **AnaLight®** instruments are important enabling tools for FMCG product R&D, providing a rapid and easy capability to:

- Measure product formulation behaviour on a range of industrially relevant surfaces
- Collect high-resolution data in the presence of turbid solutions such as fabric conditioner
- Differentiate between adsorption, absorption and desorption behaviour at molecular-scale resolution
- Study the extent and rate of these processes
- Determine the effects of salt, pH, water hardness, temperature etc. on product formulation behaviour
- Fully validate product performance claims through quantitative measurement traceable to international standards

See also [Farfield Application Note 007 “High Resolution Studies of Interfacial Polymer Physisorption and its Mediation by Surfactant”](#)

Farfield gratefully acknowledges that these experiments were carried out in collaboration with Research Scientists from Unilever Research and Development, Port Sunlight, Wirral, United Kingdom.

For further applications information contact: applications@farfield-group.com