Rheology and Microstructure of emulsion based cosmetic mascara

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Mascara is a cosmetic applied to the eyelashes to make them appear thicker, longer, and darker. Typically mascara products consist of a wax mixture dispersed in a continuous water phase. Recent mascara formulations form complex emulsions, and have numerous additives present in the continuous phase such as preservatives, surfactants, stabilisers, rheology modifiers and co-polymers. Modern application systems typically include a tube containing the bulk mascara, and an applicator brush. In such systems, the mascara rheology combined with applicator brush design are crucial, as these control the amount of mascara acquired by the brush, and therefore dictate the amount deposited onto eyelashes. Tube and brush mascara systems can have a number of drawbacks:

- The amount of material acquired by the brush is variable. In turn, the amount deposited onto the eyelashes also varies leading to uneven application.
- When applied, the mascara can cause the eyelashes to stick together before drying. Possible causes are the formulation, microstructure and rheology of the material.
- Mascara formulation, microstructure and the package design in mascara application can lead to undesirable 'clumps' appearing on the lashes.

To reduce the drawbacks listed above, it is vital to extend understanding of the material properties, in particular that of the microstructure and its influence on the rheology. The yield stress of a material, defined as the minimum shear stress applied to initiate flow has been well debated in the literature [1] and is important from a practical point of view. The rheological wallslip phenomena present in many structured products [2] was investigated using a selection of measuring geometries, and variations in yield stresses and flow characteristics were also studied by altering plate gap separations using the smooth and roughened parallel plates [3].

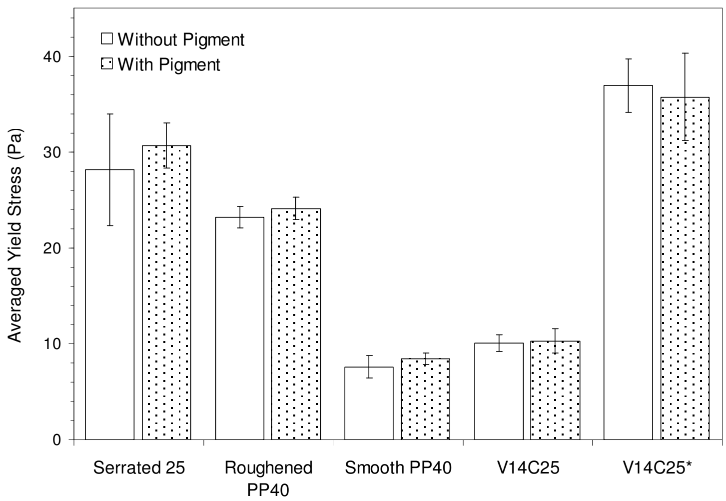

Figure 1. Averaged yield stresses of cosmetic mascara using a selection of measuring geometries.

Although increases in flow of mascara were found on decreasing gap separation of parallel plates, the yield stresses obtained from maximum peak viscosities were found to be fairly constant. The steady shear data was found to vary depending on the geometry used - the yield stresses calculated are shown in Figure 1. The vane geometry using standard form factors (assuming full flow between vane edge and cup wall) gave yield values similar to those obtained with the smooth plates. However, recalculation of the form factors using actual flow measured (V14C25*) revealed the yield stress to be substantially higher indicating the true extent of wallslip.

Determining the fundamental emulsion properties, particularly the size distribution and position of the dispersed wax phase droplets within the mascara emulsion has been a challenge. However confocal laser scanning microscopy has enabled characterisation of the microstructure without the need for intensive sample preparation. Natural fluorescence of the wax droplets [4] allowed determination of the microstructure without requiring additional fluorescent agents.

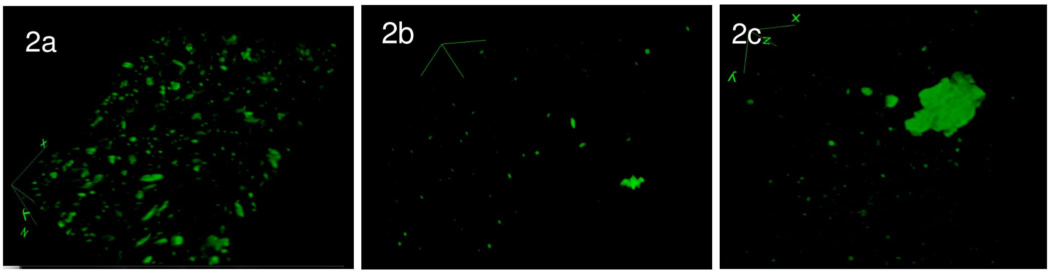

Figure 2. Confocal images showing the dispersed wax droplets produced using varied impeller speed settings during emulsification; a-9999, b-5000, c-2400 rpm.

The variables used in processing laboratory prepared mascara emulsions and their impacts on the resulting microstructure and rheology were investigated. An important factor studied was the alteration of impeller speed during emulsification of the wax phase. The impeller speeds were varied from 2400, 5000 and 9999 rpm. Image analysis of the confocal scans show that a high number of wax droplets with smaller size distributions were produced using the high impeller speed in emulsification, and a lower number of droplets with substantially larger size distributions were seen for those emulsions produced using the lower impeller speed settings.

References

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