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Biodiversity and Cosmetics: Reaching Sustainable Technology

Rheological design of topical and hair formulations for sensory and performance properties

ECFP

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Introduction

The handleability and sensory perception of cosmetic formulations can be summarised by a set of rheological properties. In our previous work [1] we set 4 design principles for hand sanitiser formulations:

- **Low runoff**: yield stress $\sigma_y \gtrsim 10$ Pa or viscosity $\eta \gtrsim 1$ Pa s at shear rate $\dot{\gamma} \lesssim 0.1$ s^{-1}
- **Spreadability** at 20 µm: shear thin to viscosity $\eta \approx 0.1$ Pa s at shear rates $\dot{\gamma} \sim 10^3$ s^{-1}
- **Smoothness**: first normal stress difference N_1 at shear rates $\dot{\gamma} \sim 10^3$ s^{-1} to prevent direct skin-skin contact
- **Not sticky**: filament breakage time of $\tau_b \lesssim 1$ s

Here, we assess the rheological properties of different topical and hair care formulations and evaluate their performance against the same four design principles.

Results

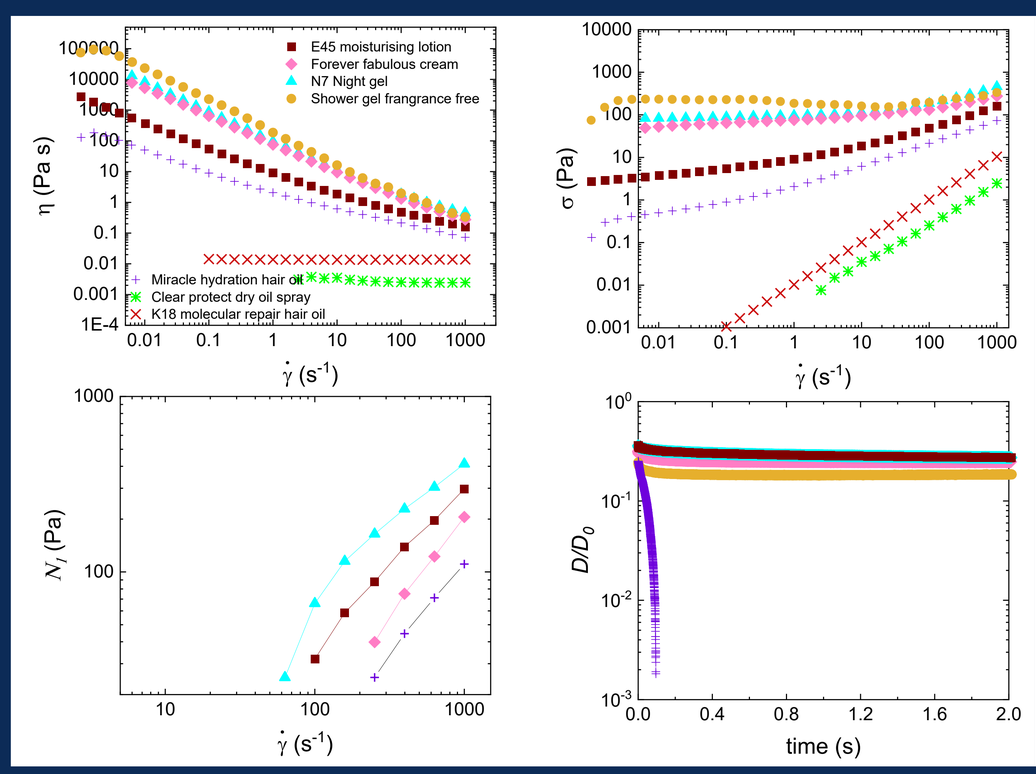
Rheological characterisation of different commercial samples highlighted differences between hair and skin products.

η, viscosity

All topical formulations showed shear thinning behaviour, whereas some hair oils displayed a Newtonian fluid-like behaviour. This means the handleability of the dry oil spray and K18 will be different to the other products.

N_1, first normal stress difference

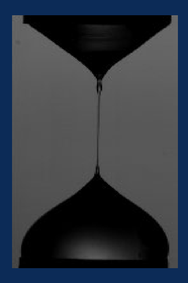
All topical products designed to be applied on dry skin met the smoothness criteria. The shower gel and some hair oils did not, but they are not applied in the same way as topical formulations.



σ, stress

All topical formulations had a yield stress suitable as "low runoff" products. Whereas the hair oils did not have a high enough yield stress to have the same handleability. The hair oils will run off the hands more easily.

D/D_0, time evolution of filament diameter



Most of the topical products designed to be applied on dry skin did not meet the non-sticky criteria (measured with extensional rheology). Perhaps, for solid-like formulations, this criteria needs to be adjusted.

Conclusion

Rheological characterisation can inform the product's sensory properties, but the design principles must be adapted for the intended use of the product and application method. The information would allow industry to better understand product behaviour; its perception and how to modify the formulation for optimal performance.

Contact us:

References

1. Silva, A.F. et al. Rheological design of thickened alcohol-based hand rubs. Rheol Acta 61, 571–581 (2022)