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Rheolaser: Light Scattering Characterization of Viscoelastic Properties of Hair Cosmetics That Are Related to Performance and Stability of the Respective Colloidal Soft Materials

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Abstract : Rheolaser MASTER™ makes use of multiple scattering of light, caused by scattering objects in a continuous medium (such as droplets and particles in colloids), to characterize the viscoelasticity of soft materials. It offers an alternative to conventional rheometers to characterize viscoelasticity of products such as hair cosmetics. Up to six simultaneous measurements at controlled temperature can be carried out simultaneously (10-15 min), and the method requires only minor sample preparation work. Conversely to conventional rheometer based methods, no mechanical stress is applied to the material during the measurements. Therefore, the properties of the exact same sample can be monitored over time, like in aging and stability studies. We determined the elastic index (EI) of water/emulsion mixtures (1 ≤ fat alcohols (FA) ≤ 5 wt%) and emulsion/gel-network mixtures (8 ≤ FA ≤ 17 wt%) and compared with the elastic/sorage mudulus (G') for the respective samples using a TA conventional rheometer with flat plates geometry. As expected, it was found that log(EI) vs log(G') presents a linear behavior. Moreover, log(EI) increased in a linear fashion with solids level in the entire range of compositions (1 ≤ FA ≤ 17 wt%), while rheometer measurements were limited to samples down to 4 wt% solids level. Alternatively, a concentric cilinder geometry would be required for more diluted samples (FA > 4 wt%) and rheometer results from different sample holder geometries are not comparable. The plot of the rheolaser output parameters solid-liquid balance (SLB) vs EI were suitable to monitor product aging processes. These data could quantitatively describe some observations such as formation of lumps over aging time. Moreover, this method allowed to identify that the different specifications of a key raw material (RM < 0.4 wt%) in the respective gel-network (GN) product has minor impact on product viscoelastic properties and it is not consumer perceivable after a short aging time. Broadening of a RM spec range typically has a positive impact on cost savings. Last but not least, the photon path length (λ*)—proportional to droplet size and inversely proportional to volume fraction of scattering objects, accordingly to the Mie theory—and the EI were suitable to characterize product destabilization processes (e.g., coalescence and creaming) and to predict product stability about eight times faster than our standard methods. Using these parameters we could successfully identify formulation and process parameters that resulted in unstable products. In conclusion, Rheolaser allows quick and reliable characterization of viscoelastic properties of hair cosmetics that are related to their performance and stability. It operates in a broad range of product compositions and has applications spanning from the formulation of our hair cosmetics to fast release criteria in our production sites. Last but not least, this powerful tool has positive impact on R&D development time—faster delivery of new products to the market—and consequently on cost savings.

Keywords : colloids, hair cosmetics, light scattering, performance and stability, soft materials, viscoelastic properties
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