Tuning Surfactant Microstructure and Rheology: From Micellar Anisotropy to Associative Network Formation

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This work presents a comparative analysis of two distinct strategies for tuning the structure–property relationships in surfactant-based personal care formulations: the use of a low-molecular-weight co-surfactant (cocamide monoethanolamide, CMEA) in AOS/CapB systems, and a polymeric associative thickener (PEG-120 Methyl Glucose Dioleate, ANTIL 127) in SLES/CapB formulations.

In the AOS/CapB system, CMEA induces a transition from spherical to anisotropic ellipsoidal micelles, accompanied by reduced electrostatic repulsion and increased micellar volume fraction. These changes enhance intermicellar interactions and lead to a significant increase in viscosity, without the formation of a viscoelastic network, as confirmed by the predominance of viscous behavior (G'' > G'). Upon incorporation of the botanical oil as a dispersed phase, the system is also capable of forming a stable emulsion without significant changes in viscosity and shows enhanced wettability.

In contrast, the addition of ANTIL 127 to SLES/CapB promotes the formation of more complex supramolecular assemblies through polymer-mediated associative interactions. This mechanism enables the recovery of viscosity and the development of viscoelastic properties even under low surfactant concentration and weak electrolyte conditions, where conventional thickening strategies are ineffective.

Overall, the comparison highlights two fundamentally different thickening mechanisms: micellar growth and anisotropy in the case of CMEA, versus network formation via associative bridging in the case of ANTIL 127. While the former offers a simple and effective route to viscosity enhancement, the latter provides a more versatile and robust strategy for achieving structured, viscoelastic formulations. These findings offer a rational framework for selecting formulation strategies based on targeted rheological and interfacial performance.

Keywords:
Structure-Property Relationships, Thickening Mechanisms, Micellar Anisotropy, Associative Bridging, Rheological Control

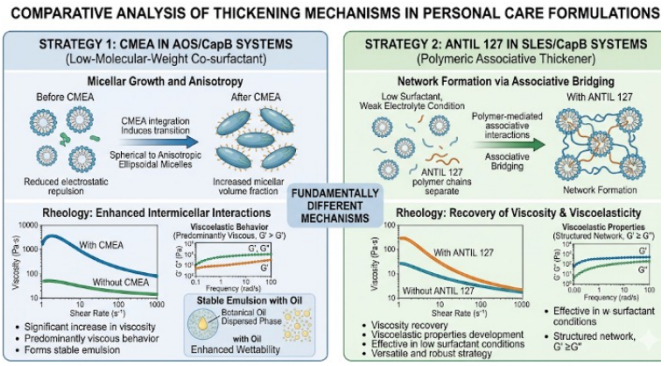

Figure 1. Structure-property relationships in thickening mechanisms. Comparison between CMEA-induced micellar anisotropy and ANTIL 127 associative bridging. Molecular architectures define the system's rheological profile. (Image generated with AI assistance).