Influence of static electric field on the surface tension of selected aqueous solution; interest to stabilize interfaces in foams and emulsions

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Foams are thermodynamically unstable systems and their stabilisation remains a challenge. This project aims at investigating the interest of static-electric-fied (SEF) on the stability of foam systems since SEF is expected to reduce the surface-tension force of some liquids such as water.

Investigations; selected aqueous solutions (water, WPI solution, chickpea liquor) were studied using a modified pendant droplet tensiometer (TECLIS-France). Two parallel electrodes were installed around the pendant droplet and were subjected to a range of DC voltages (0 to 10 kV) corresponding to SEF in the range of 0-250kV/m. The images of the droplet were recorded throughout the experiment. Based on Laplace's equations and thanks to an algorithm that uses the profile of the drop, the surface-tension force was calculated as a function of the applied voltage.The geometry of the drop was deformed under the action of SEF. The drop were elongated with increasing SEF and the deformation was perpendicular to the SEF direction. In agreement with previous publication, the surface-tension decreased proportionally to the rise of the applied SEF. A linear fit was observed and was compared to theoretical model developed by Sato (1997).

Further tests were done using a modified FoamscanTM system (TECLIS-France) equipped with parallel electrodes to the foam column, showing that SEF yielded very stable foams with a reduction of the drainage.
The mechanism causing surface-tension reduction was found to be linked to the electric charge located at the interfaces. By reducing the surface tension, gas bubbles or liquid droplets exposed to SEF are likely to break up more easily under shearing conditions (foaming process), offering new horizons in terms of process to obtain “clean labelled” foams or emulsions. In the case of foams, the formation of smaller cells under SEF are expected, which may yield less destabilization phenomena (coalescence, drainage) and a more stable foam during storage.

As a conclusion, the use of SEF in the case of foams or emulsions appears as an innovative method that would allow to stabilize a foam durably, by limiting the use of additives in the product, while reducing the energy consumption during processing.