
Design of biomimetic coatings to mitigate dairy fouling

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In food processing industries, products and especially dairy products undergo thermal treatments (pasteurization, sterilization) leading to fouling formation on heat exchangers' surfaces. These deposits can contaminate dairy products during pasteurization process and also impair heat transfer mechanism by creating a thermal resistance, thus leading to regular shut down of the processes. Therefore, periodic and drastic cleaning-in-place (CIP) procedures are implemented. These CIP involve the use of chemicals and high amount of water, thus increasing environmental burden. It has been estimated that 80% of production costs are owed to dairy fouling deposit.

To reduce dairy fouling, two pathways have been considered: (i) Process conditions optimization, mainly tested by food-processing industries and (ii) Stainless steel surface anti-fouling or fouling-release coating to either inhibit attachment of depositing species or to ease their removal during cleaning respectively.

In our team, we focus on this latter approach by developing biomimetic coatings (slippery liquid-infused surfaces (SLIS) and atmospheric plasma nano-structured coatings) of low contact angle hysteresis to limit fouling adhesion onto stainless steel surfaces. Slippery liquid-infused surfaces are inspired by Nepenthes plant by designing slippery interface between the substrate and the fouling providing fouling-release surfaces. Slippery surfaces were elaborated in three steps: (i) femto laser surface structuring, (ii) silanization and (iii) lubricant impregnation. In order to maximize lubricant retention, laser manufacturing parameters were optimized.

Plasma nano-structured coatings intend to mimic lotus leave surfaces, by creating a dual-scale roughness preventing adhesion of denatured dairy proteins. Hydrophobic multilayer silane/fluorosilane based coatings were sprayed by atmospheric pressure plasma (ULS, Axcys Technologies) and conditions were optimized depending on the fouling test results obtained.