FOULING AND CLEANING OF MILK COMPONENTS ON DLC-COATED SURFACES

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The unwanted formation of deposits during the thermal treatment of milk and milk products is a unresolved problem for the dairy industry. The attachment, adhesion, retention and removal of foulant components is influenced by the interaction between heat transfer surface and process fluid. A method to reduce fouling is the defined modification of the energetic and topographic surface properties. An anti-fouling surface, safe for use in the food industry, easy to clean, resistant in operation and effective over the lifetime of a plant is still a challenge. This study investigated the potential of Diamond-Like-Carbon (DLC) coated surfaces with particular high mechanical hardness, wear resistance and chemical inertness, on fouling mitigation and cleaning enhancement.
The fouling behaviour of WPI and SMUF (simulate milk ultrafiltrate) on DLC, SICAN and SICON® coatings has been examined. The results were compared with standard and electro-polished stainless steel surfaces. Fouling experiments were carried out in a temperature controlled vessel with coupons fixed on an electrical heating element. The initial surface temperature was adjusted to 80°C or 120°C, respectively. The fouled surfaces were cleaned with NaOH- and HNO_3-solutions until the surface was free from residuals. In order to investigate the influence of surface modifications on fouling and the potential aging of the coatings, X-ray microanalysis of the surfaces as well as surface energy measurements were carried out.
Fouling curves for the different coated surfaces for WPI and WPI dissolved in SMUF at low and elevated initial surface temperatures show the different influences of the coatings on fouling behaviour: i) a positive effect of SICAN coatings on deposit growth attenuation and the enhanced cleanability of SICON® coating, that is comparable with stainless steel, could be observed; ii) at elevated temperatures the initial fouling growth rate is lower for the coated surfaces; iii) the aging process of the coatings affects the fouling behaviour (see Fig. 1); iv) a change of the surface energy with successive fouling and cleaning runs was monitored and a gradial increase of the polar part could be noticed; v) the number of required cleaning cycles increased with the number of experiments, the polar part of the surface energy becomes constant, and the required number of cleaning cycles drops again.
The results also suggest that the initial interaction of the deposited layer with the surface is more important for the cleaning behaviour than the total amount of deposit built up.

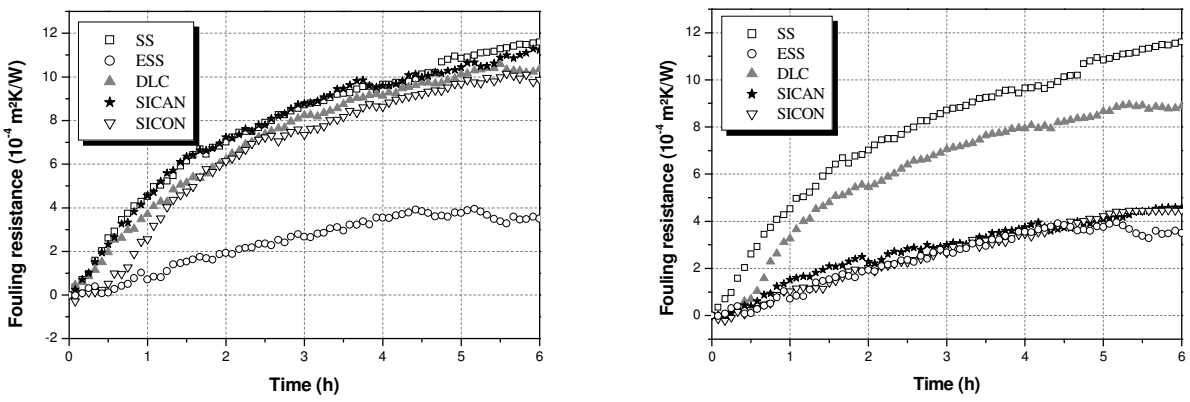

Fig. 1 Fouling progress for WPI in SMUF at T_o = 80°C on new (a) and used (b) DLC-coated surfaces