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Zwitterionic diamond-like carbon coatings with antifouling properties.Stefan Kotula¹, L. Schnöing², L. Bialuch³, L. Bröcker¹, F. Haller¹, W. Pedt¹, W. Augustin¹, S. Scholl², C.-P. Klages¹¹Inst. f. Oberflächentechnik - TU BS, Braunschweig, Germany ²ICTV - TU BS, Braunschweig, Germany ³FhG-IST, Braunschweig, Germany

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The accumulation of unwanted material (“fouling”) on technical surfaces is a well-known problem in many sectors of industrial manufacturing with one very relevant example being milk processing. Here, fouling occurs due to accumulation of mineral and protein components from the milk, which is a great issue especially on heat transfer surfaces. A number of investigations applying surface coatings for fouling mitigation are known, with a moderate success so far. In a fairly new approach, zwitterionic surfaces, i.e., surfaces containing basic (e.g., amine) as well as acidic (e.g., carboxylic acid) functional groups, are utilized for the protection of surfaces against fouling. Normally such layers are fabricated via coupling of monomers containing acidic and/or basic functionalities which is not suited for food processing due to thermal, chemical and mechanical instability. In the present work a RF PECVD process was used to deposit zwitterionic DLC layers containing heteroatoms (e.g., O, N) which are present in the form of acidic and basic functional groups. As precursors we used (i) combinations of a hydrocarbon (CH₄, C₂H₂) together with a heteroatom source (N₂, O₂, NH₃) and (ii) single precursors containing heteroatoms (e.g., pyrrolidine), respectively. Coatings were characterized by zeta-potential and surface-free-energy measurements. Also we used a tailor-made in situ ATR-FTIR setup to investigate functional groups attached to the surface. Fouling investigations, which were carried out in a laminar-flow channel using aqueous solutions containing whey protein and salts, showed promising results of the zwitterionic DLC with respect to fouling mitigation. To reveal possible mechanisms of the fouling process, an ATR-FTIR setup was used which allows in situ measurements in contact with aqueous solutions. Therewith it was shown that the fouling process is affected by the presence of charged groups on surfaces.

Keywords

Antifouling

Milk deposits

Zwitterionic DLC

in-situ ATR-FTIR