INVESTIGATING THE POTENTIAL FOR THE USE OF PHOTOCATALYTIC SURFACES IN PROCESS HYGIENE IN THE BREWING INDUSTRY

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ABSTRACT

Process hygiene plays a major role in ensuring beer quality. One approach to the reduction of fouling in this industry - and in any other associated with food production - is the use of photocatalytic surfaces such as those including titania (titanium dioxide), which is active under UV light. These coatings are inert when not photoactive, and their self-cleaning attributes are ecologically and toxicologically desirable. TiO_2 coatings can be doped with transition metals (in this case, molybdenum, tungsten and niobium) to extend activity under fluorescent light. The aim of this study was to produce doped coatings on stainless steel and to explore their potential for use in the brewing industry.

Coatings were produced using magnetron sputtering. Characterisation indicated the presence of photoactive phases of titania (anatase and rutile) as well as the presence of dopants. Assessment of photocatalytic activity was via degradation of methylene blue. Tests for chemical resistance to acid and alkali (components of potential cleaning products) indicated that the coatings were robust, well attached to the substratum, and that they retained their photoactivity. Photocatalytic antimicrobial activity was explored using three brewery isolates and Escherichia coli (following ISO 27447:2009).

The addition of molybdenum to the coating enhanced activity under fluorescent (visible) light in comparison to titania alone, but the surface was also antimicrobial in the dark. This innate antimicrobial activity was attributed to the presence of molybdenum. Thus these coatings presented dual function: antimicrobial and photoactive. The addition of niobium enhanced activity under fluorescent light, but no innate (dark) activity was noted. Any effect of tungsten was concentration dependent.

Titania-molybdenum surfaces were placed in the brewery environment (around filling lines) for 12 months, and were tested three times for photocatalytic activity and stability of coating. The use of small numbers of samples precluded statistical analysis of data, but there was evidence that photoactivity was retained to varying extents, and molybdenum was also largely retained on the coating. There was also some damage visible in terms of coating stability on occasion. Longer term studies investigating any antimicrobial or antifouling properties of the surface failed to demonstrate significant effects, again likely attributable to the very low numbers of replicate samples.

Overall, findings indicate potential for these doped surfaces in enhancing plant hygiene and complementing existing cleaning and disinfection protocols, whilst offering both innate (antimicrobial in the dark) and photoactive properties. Further work will explore the stability of these coatings, batch variability, and the development of additional in vitro tests prior to in situ investigations.