

ICA-11

Boric Acid Dispersion of Biofilm (BAD-B)

Principal Investigator(s): Starla G. Thornhill

Technology Taxonomy Area (TX): 6.1.2 Water Recovery and Management

TRL: Start 1 / Current 3

FY21 IRAD PROJECT OVERVIEW

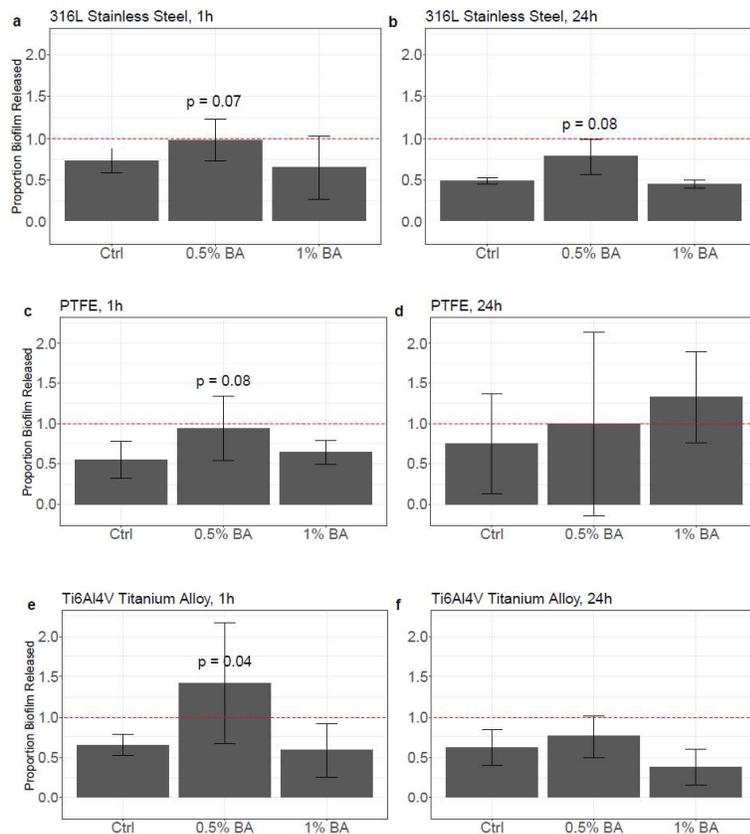
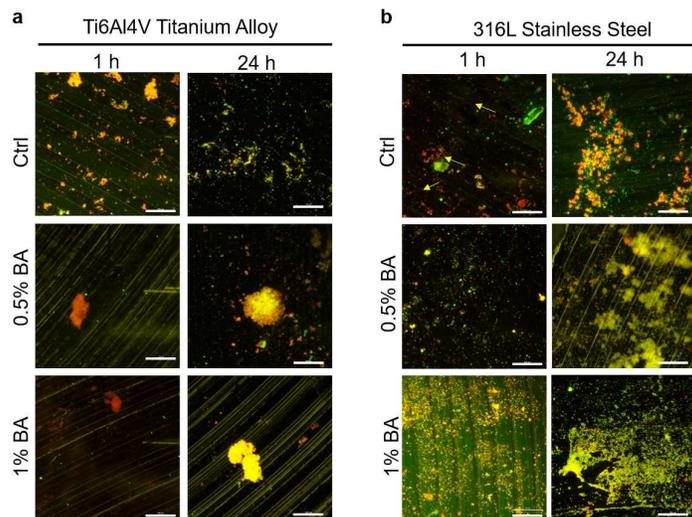
Biofilms in spacecraft water recycling systems (WRS) can cause crew illness, occlude water lines, and induce corrosion on WRS materials. The treatment of biofilms in spacecraft water systems has historically been limited by a lack of suitable methods to overcome biofilm-associated antimicrobial tolerance (AMT). One way to get around AMT is to induce biofilm dispersion. To address AMT in spacecraft WRS, I evaluated the use of boric acid (BA) as an agent to disperse biofilms formed on common WRS materials, including 316L stainless steel, PTFE Teflon, and Ti6Al4V titanium alloy. Recent studies have shown that BA can be effective at dispersing biofilms of a variety of bacterial species. BA has also been shown to interact synergistically with antibiotics and disinfectants.

INNOVATION

BA is a common additive to household medical solutions, like contact lens solution, ear washes, yeast infection medications, and antiseptics, and is used in the food industry to preserve the coloration of shellfish. BA is also commonly used as a household insecticide due to its low toxicity in humans. Although BA is widely used in a variety of industries, the use of BA as a biofilm dispersant has only been recently discovered and has only been investigated as a dispersant against biofilms on rocks and silicone. Moreover, the practical application of BA as a biofilm dispersant in water recycling systems has not been investigated to date. Inducing biofilm dispersion is one way in which antimicrobial tolerance typical to biofilms can be reversed, which could increase the efficacy of existing disinfection procedures already in use on ISS.

OUTCOME

This project provided proof-of-concept for BA-induced dispersion of biofilms formed on common spacecraft materials.



Above: BA-induced biofilm dispersion quantified as the proportion of cells released from the coupon after soaking in Butterfield's buffer (Ctrl), 0.5%, or 1% BA compared to the number of cells mechanically removed after soaking. The red dashed line indicates the level of complete biofilm removal, and bars that end below the red line indicate incomplete dispersal by the treatment agent. Treatment with 0.5% BA for 1 hour on all materials results in a significant increase in dispersion on all tested materials. (Statistics: One-sided Z test for proportions, 90% CI)

Left: Fluorescence microscopy of biofilms on 316L stainless steel (left) and Ti6Al4V titanium alloy (right) after soaking in Butterfield's buffer (Ctrl), 0.5%, or 1% BA. Green indicates live bacterial cells; red indicates dead bacterial cells. PTFE Teflon could not be imaged due to a high level of background fluorescence.

FUTURE WORK

As a follow-up to this study, I will be seeking an IRAD to investigate the synergistic effect between BA-induced biofilm dispersion and disinfection with spaceflight water recycling system (WRS) disinfectants, with the aim to update the current methods for treating high microbial load in spacecraft WRS to increase the efficacy and longevity of antimicrobial treatment.