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# Long Term Uses of Potable Water Containing Silver Disinfectant in High Surface to Volume Ratio Metallic Surfaces

### Background

Silver is a broad-spectrum biocide with high antimicrobial efficiency that is currently used on the International Space Station for disinfection of the water supplies. However, silver is known to react with some metallic components of water storage systems, which results in a gradual loss of biocidal silver ions over time in the water. This process is thought to be done through a galvanic deposition process, with a concomitant oxidation of the substrate and reduction of silver ions to metallic silver or silver oxides on the surface.

Surface treatments including acid passivation, silver plating, electropolishing, and heat treatment can also affect the silver deposition rate on different materials. However, most current surface treatments are ineffective when the surface to volume ratio is increased.

2D materials, which are nanometer scale, atomically thin materials, are promising candidates for the fabrication of effective, robust, and economical coatings due to their ultimate thinness and excellent mechanical properties. Homogenous coating on stainless steel can be achieved by thin film deposition techniques, which allows for a controllable thickness on the surface. However, the use of ceramic coatings as insulators to prevent the reduction of silver on stainless steel has not yet been explored.

### Invention Description

Researchers at Arizona State University and Cactus Materials, Inc. have developed a novel method to increase the stability of biocidal silver in the water treatment and storage systems of spacecrafts. This method limits redox reactions occurring on metallic surfaces by applying a nanoscale-thin coating of ceramic 2D material. The coating is applied by thin film deposition techniques to provide a continuous and homogenous nanoscale surface insulating coating of controllable thickness. Initial results showed less than 5% silver loss on 316L stainless steel coated with only nanometers (less than 250nm) of ceramic materials.

### Potential Applications

- 2D alumina coating for high surface to volume ratio complex geometries to protect metallic deposition from water (e.g., pipes, tanks)
- Anti-biofouling protection in medical devices (e.g., catheters)
- Anticorrosion and wear resistant coating for stainless steel and other substrates

#### Benefits & Advantages

- Highly stable at high temperature due to atomic layer deposition coating process
- Prevents coating detachment even at high temperatures
- Effective at a much lower thickness than polymer coatings
- Ceramic materials are 40-100 times harder than traditional polymer coatings (limits risk of coating damage during assembly)
- Can be used for high surface to volume ratio applications