

Synergistic microwave and silver nanoparticle treatment and the potential for efficient inactivation of *Legionella pneumophila*

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How this work promotes sustainable nanotechnology?

This work utilizes nano-scale silver to harness microwave radiation and inactivate a pathogen *Legionella pneumophila*. The nano-silver serves as a constant source of ionic silver, which in presence of microwave radiation compromise cell integrity more effectively. Silver nanoparticles bring in their unique properties to inactivate pathogens in water. This approach relies on nanosilver and serves to disinfect water.

Abstract

Legionella pneumophila is a virulent bacterial pathogen that can cause a severe and deadly form of pneumonia called Legionnaires' disease. Risk of infection increases when *L. pneumophila* are harbored inside free-living amoebae, which are resistant to traditional disinfection processes but lyse upon heat exposure. This project aims to develop a point-of-use technology based on microwave (MW) radiation and nanomaterial (e.g., silver, copper oxide, carbon nanotubes) exposure for *L. pneumophila* control. In this alternative technology, we hypothesize that amoebae will be lysed via localized interfacial heating, and the released *L. pneumophila* will be inactivated subsequently by heat, metal ions (from nanoparticle dissolution), and reactive oxygen species (ROS) produced in the process. The synergistic effect of microwaves and silver nanoparticles for enhanced, rapid inactivation has been demonstrated for *Escherichia coli* and planktonic *L. pneumophila*. Inactivation greater than 3-logs of each species has been achieved when subjected to silver nanoparticles (2-5 mg/L) and MW (2,450 MHz; 70 W) radiation. A mechanistic study using *E. coli* has determined the dominant interaction to be between released ions and MW radiation. Ultimately, the nanomaterials will be immobilized on a plaster of Paris or ceramic surface for flow through applications where both amoeba lysing and *L. pneumophila* inactivation will be achieved.