Synergy between Microwave Radiation and Silver for Inactivation of *Legionella pneumophila*

Navid B. Saleh, Craig Ayres, Desmond F. Lawler, and Mary Jo Kirisits

Department of Civil, Architectural and Environmental Engineering, The University of Texas at Austin, Austin, TX 78712

Legionella pneumophila is an opportunistic human pathogen that can cause a severe and deadly form of pneumonia called Legionnaires' disease. Over the past decade, the number of reported cases of Legionnaires' disease has quadrupled in the U.S., with 8,000-18,000 hospitalizations per year at a yearly incidence rate of 1.7/100,000. Within the water sector, this public health risk is exacerbated by the proliferation of *L. pneumophila* in complex biological matrices such as biofilms and within free-living amoebae. Traditional disinfection technologies fail to effectively mitigate this emerging pathogen issue, necessitating development of point-of-use (POU) technologies with high inactivation efficacy. We aim to harness microwave (MW) radiation and take advantage of its synergy with ion-mediated toxicity to effectively inactivate *L. pneumophila*. In this study, planktonic *L. pneumophila* cells have been exposed to ionic and nano-particulate silver. While neither treatment alone is effective over a short exposure period, a combined treatment of silver with MW radiation successfully achieves 3-4 log removal within 6 min of irradiation, as shown in Figure 1. Enhanced toxicity was observed when *L. pneumophila* was pre-exposed to either treatment (i.e., MW heating or silver exposure) prior to exposure to the other; these results suggest that silver ion transport within the cells is facilitated by heat treatment. Data presented here serve as the proof-of-concept toward the development of a *L pneumophila* inactivation device that harnesses MW radiation and can potentially mitigate this public health risk, even if the cells are protected by amoebae or biofilms.

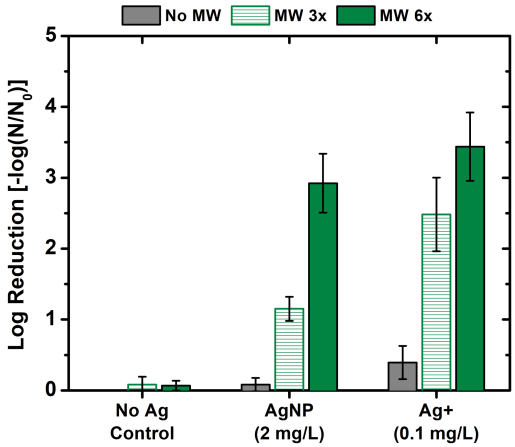

Figure 1. Inactivation of *L. pneumophila* exposed to silver nanoparticles (AgNPs), aqueous silver ions (Ag^+), and/or MW radiation (2.45 GHz; 70 W). Pulsed MW exposure consisted of 1 min pulses with 2 min of break for a total MW exposure time of 3 minutes (3x) or 6 minutes (6x)