

HEALTH & HUMAN SCIENCES

Application of Novel Innovations: Iron and Manganese Nanoparticles Produced Using a Spark Discharge System

Student researcher: Kaushal Prasad, Senior

Welding is a manufacturing process that emits metal fumes as a by-product. These fumes contain metallic nanoparticles (smaller than 100 nm) that react with ambient air to form metal oxide particles. A large proportion of metallic nanoparticles are elements such as manganese (Mn), iron (Fe), chromium (Cr), and nickel (Ni). Some metals, for example, Mn can contribute to the toxicity in welding fumes.

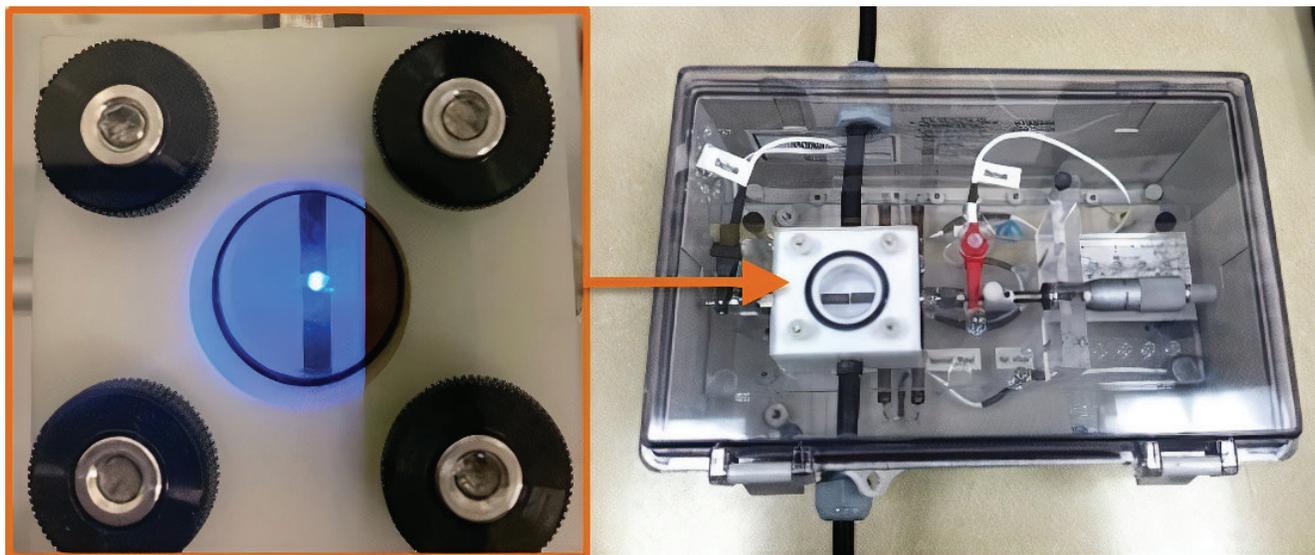
According to the Centers for Disease Control and Prevention, welders in the United States have experienced adverse health effects from chronic exposure to metal fumes. Numerous studies have found that the health effects are associated with slower reaction times, hand tremors, and Parkinson's disease-like symptoms.

To characterize welding fumes in a stable and controlled manner in a lab, a spark discharge system (SDS) was

developed. The SDS simulated the generation of welding fumes from Mn and Fe alloy electrodes. Particle sizes and the total number concentrations were measured in real time with a scanning mobility particle sizer. X-ray fluorescence validated the metal contents in the welding fumes and manganese/iron electrodes. The generated particles from the SDS were collected using a mixed cellulose ester filter and then analyzed using the X-ray fluorescence.

Alloy electrodes with higher Mn content produced larger-sized metal particles and a greater total number of concentrations of particles. These results provided further insight into the composition and toxicity of metal fumes emitted from welding. Future toxicological studies can utilize the SDS to generate metallic nanoparticles and evaluate their toxicity upon exposure.

Research advisor Jae Hong Park writes: "Kaushal Prasad generated the nanoparticles with different compositions. He found that nanoparticles generated using the SDS had the same compositions as the electrodes. The results will be used to design future toxicology studies and the system will be combined with exposure systems to evaluate the effect of nanoparticle composition on toxicity."



Spark generation between welding electrodes utilized in the Spark Discharge System.