Characterization of Arc Generated Plasma Interactions with a Liquid Metal Medium

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The study of the interaction of plasma with liquid metals is a key component to future fusion devices design. With liquid metals being considered as inner wall material for both torodial and inertial confinement fusion devices it is important to be able to predict the way in which the liquid metal wall will interact with the fusion plasma. This study focuses on the plume of liquid metal created when the plasma impacts on the liquid metal medium and the results will be applicable in inertial confinement design. The liquid metal plume will be characterized using data on the particulate liquid metal colleted on aluminum buttons positioned in various locations; with this information plume shape, density and velocity can be determined. Also of interest is the size of the particulate matter ejected from the liquid metal medium.

Data on the plume is collected using the "Arc Generated Explosion Impact on Substrate" (AGEIS) device. This device is a metal cylinder with multiple ports for the two separate electrodes, fiber optic line, pressure regulator and gage, and an electrical port for the heating element wires and the thermocouple wires. The internal structure of the cylinder consists of a metal box frame that holds the heating plate element at the bottom of the cylinder and has adjustable arms attached with collector buttons. The plasma is generated using a taut copper wire stretched between the two electrodes; a large capacitor bank is used to pulse energy into the wire vaporizing it and creating a copper plasma which is further sustained by arcing between the two electrodes. A liquid lead pool is positioned on the heating plate such that the pool surface is 1.5cm below the copper wire. The wire length is 5cm long making it wider than the pool diameter so that the electrode tips don't interfere with the plume formation. A fiber optic line is positioned to collect spectrum data on both the wire and the pool. The current and voltage input into the wire are recorded in time using a high voltage probe and a Pearson coil for the current. The electrical data along with the spectrum data allow for the characterization of the plasma that impacts on the liquid lead pool. The entire cylinder is maintained at a pressure of 20 Torr because lowering the pressure causes the breakdown of the air in the chamber when the power is pulsed into the system. For the characterization of the plume, multiple collector buttons are used in each "shot" with the same parameters for the system and then moved to cover different geometries and velocities. A scanning electron microscope is used to identify the size and density of the particulate matter on the buttons and using multiple locations for the buttons with the same system parameters will allow for the plume to be fully modeled. System parameters can then be changed and the process repeated to determine which system parameter changes affect the plume formation.