Improving Ultrasonic Waves Transmission in Liquid Metals in High-Temperature Environment

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Liquid metals offer interesting electrical and thermal properties that are used in many different fields such as medicine, electronics, computing and nuclear power. For instance, molten salt and fast neutron nuclear reactors use liquid metals due to its superior heat-transfer capabilities. Unfortunately, the use of liquid metals in such reactors render nondestructive inspections difficult. Their opaque nature makes visual inspection impossible and the body of literature on the propagation of ultrasonic waves in liquid metals is limited. In order to simplify experimental procedures, this paper focuses exclusively on Galinstan as it is chemically compatible with a large variety of metals, liquid down to -19°C, and is safe to handle. Nevertheless, Galinstan quickly oxidizes in uncontrolled atmosphere by forming a thin and impermeable oxide layer at its surface. This oxide layer is common across many liquid metals and also happens to be one of the main issues in the transmission of ultrasonic waves. Therefore, this paper presents an experimental investigation on methods to improve the transmission of ultrasonic waves through the oxide layer of Galinstan at room temperature as well as at elevated temperature. Multiple parameters including oxidation time, the material in contact with Galinstan and various chemical agents were studied. The results show that by selecting the optimal parameters, the transmission of ultrasonic waves can be improved by as much as 25 dB. Current research is currently focused on extending the results to other liquid metals such sodium and lithium.