Molten Salt Hot Wire Sensor for Thermal Conductivity

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The use of molten metals and salts have become increasingly important in industry with a wide array of applications; their use in the power industry is of particular interest. Experts in the field of Generation IV nuclear reactors have found the development of molten salt reactors to be important because of their unique capabilities of enhanced safety, efficiency, and a (potential) radical decrease in size from standard pressurized water reactors. In order to commercialize this new reactor type, extensive licensing requires an in-depth understanding, prediction, and optimization of physical properties of salts for safe operation. Although thermal properties are critical to those areas, obtaining reliable data is complicated and much of the work done in the past does not agree at higher temperature values required for the molten salt reactor. The current research proposes a solution to these inconsistencies by creating a highly accurate sensor that can withstand these high temperatures using the transient hot wire technique. Because molten salts conduct electricity, a diamond substrate was selected to make the hot wire electrically isolated from the fluid as well as providing excellent thermal conductivity to allow for effective heat transfer. Three hot wires are used to remove edge effects creating a wire of finite length that, combined with a custom wheatstone bridge circuit, allows for change in resistance to be recorded. With the help of a finite element analysis, thermal conductivity can be accurately recorded with convection canceled out and radiation effects included in the model.