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#06-208 Optimized High Temperature Irradiation Resistant Thermocouple for Fast Response Measurements

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The High Temperature Irradiation Resistant thermocouple (HTIR-TC) is the only temperature probe proven to withstand both the high temperatures (e.g. >1290 ℃) and high radiation (e.g. up to a fluence of 1E21 n/cm2) of nuclear reactor fuel design tests and/or over-temperature accident conditions. The HTIR-TC heat treatment, calibration, and in-pile performance during the Advanced Gas Reactor 5/6/7 fuels tests inside the Idaho National Laboratory's Advanced Test Reactor have been previously shared. The current work describes the improved performance of the molybdenum versus niobium thermocouple by utilizing a coaxial design—i.e. single-wire grounded to the outer sheath. The thermocouple junction is formed at the end of the coaxial cabling by swaging the sheath down and welding to the inner wire. This optimized HTIR-TC is more concise by simplifying the design while allowing for more robust individual components. The niobium and molybdenum thermoelements can be interchanged as sheath or wire depending on the application. Using a plunge test in flowing water, the coaxial build of the HTIR-TC was found to be 30x faster in response time than ungrounded Type K TCs, and 10x faster than both grounded Type K TCs and traditional ungrounded HTIR-TCs (i.e. two-wire configuration). Further, by capitalizing on the coaxial design, a multi-core HTIR probe has been proven with multiple 'single-pole'wires down the length of the sheath. Each wire is then terminated and formed into a junction with the inside of the outer sheath at the location where temperature measurement is desired. This multi-core thermocouple design has been dubbed "demicouple."The primary application of the HTIR demicouple is during fuel experiments to achieve multiple fuel pin centerline temperature measurements in one compact sensor. However, the shared 'common'leg between demicouple junctions reduces error propagation in secondary measurements such as temperature differentials.

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