Integrated sensors handle extreme conditions

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A team of Case Western Reserve University engineers has designed and fabricated integrated amplifier circuits that operate under extreme temperatures – up to 600 degrees Celsius - a feat that was previously impossible.

The silicon carbide amplifiers have applications in both aerospace and energy industries. The devices can take the heat of collecting data inside of nuclear reactors and rocket engines, for example.

Dr. Steven L. Garverick, a professor of electrical engineering and computer science, describes the team's work in a paper he presented May 31 at the 2012 IEEE EnergyTech conference, held at Case Western Reserve. The paper is coauthored by Ph.D. candidate Chia-Wei Soong and Mehran Mehregany, director of the Case School of Engineering, San Diego program.

These integrated circuits are constructed on a wide-band-gap semiconductor. According to Garverick, "Most semi-conductors are made out of silicon, but silicon will not function above 300 degrees Celsius, and there are some important applications above that range."

His team's solution is to use silicon carbide. At high temperatures, the material begins to act as a semiconductor.

Engineers at NASA Glenn Research Center, in Cleveland, pioneered techniques used to manufacture these circuits. Team members at Case Western Reserve have used them to fabricate complete circuits by depositing three distinct silicon carbide layers on top of silicon carbide wafers, which altogether measure one-tenth of the thickness of a human hair.

These circuits are designed to replace the "dumb" sensors currently used in high-temperature applications. The simple sensors can't take the heat and instead require long wires that connect them to the high-temperature zone.

These circuits can experience considerable interference, which makes signals unclear and difficult to decipher. The physical enclosures and wiring used in the manufacture and installation of non-integrated sensors introduces additional error.

Integrating the amplifier and sensor into one discrete package and placing the package directly where data is being collected improves signal strength, clarity and produces more reliable information.

The researchers believe this will ultimately result in more accurate monitoring and safer control over a jet engine, nuclear reactor or other high-temperature operations.

The team has built a suite of circuits ranging from simple low-accuracy versions to more complex models that return far better data. Garverick said the team will continue developing the technology and believes that commercial production is about five to ten years away.

Provided by Case Western Reserve University