A Multiplasma Microsystem With Pressure Sensor, Gas Purifier, and Chemical Detector Designed for Harsh Environments

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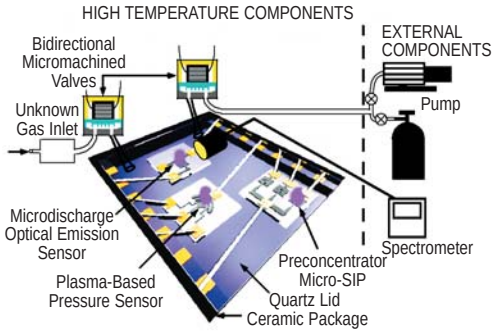
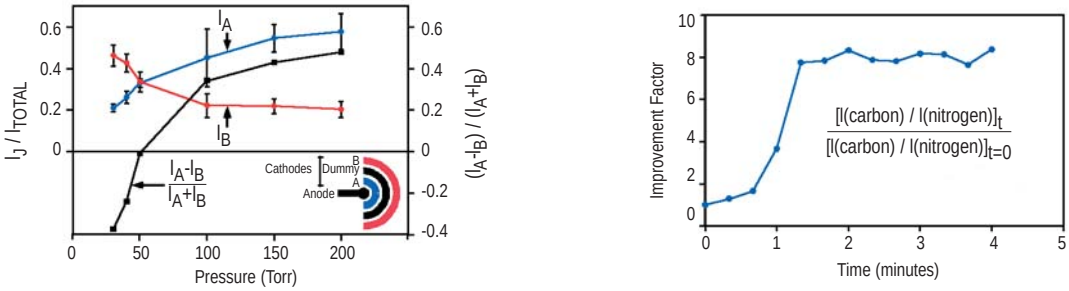


Schematic of chemical detector.

The costs of petroleum exploration, field development, and long-term geological monitoring potentially can be reduced through the use of microholes and MEMS sensors. In the pursuit of this goal, the WIMS ERC has developed a system for gas-phase chemical detection in harsh environments that uses three microplasma-based devices and operates at temperatures up to 200°C. A pressure sensor, gas purifier, and chemical detector operate through the creation of microplasmas between thin-film electrodes. A new pressure sensor design has been developed for this project that measures the change in microplasma current distribution with pressure and achieves a sensitivity of 9800ppm/Torr at 200°C. A gas-purifying microscale sputter ion pump is used to purify a sampled gas by selectively removing nitrogen and oxygen, and it achieves a 56.5x reduction in nitrogen concentration relative to helium. This purification enhances the ability of the harsh-environment sensor to detect trace amounts of gases. The chemical detector comprises a novel optical emission sensor that operates by fractionating and exciting gas species in a microdischarge for chemical spectral detection. Sample gases have been introduced into the system at 200°C, and an 8x spectral enhancement of carbon line emission intensity relative to nitrogen has been demonstrated, making the previously undetectable carbon detectable. ■



The change in microplasma current distribution with pressure in a plasma-based pressure sensor (left). Increased ability to detect carbon during gas purification in the sensor (right).