Progress in application of High Temperature Superconductor in Tokamak Magnets.

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It has long been known that high temperature superconductors (HTS) could have an important role to play in the future of tokamak fusion research. Here we report on first results of the use of HTS in a tokamak magnet and on the progress in design and construction of the first fully-HTS tokamak. The two copper poloidal field coils of the small tokamak GOLEM were replaced by two coils with 6 turns of HTS (Re)BCO tape. Liquid nitrogen was used to cool coils to below the critical temperature at which HTS becomes superconducting. Little effect on the HTS critical current has been observed for perpendicular field up to 0.5T and superconductivity has been achieved at ~90.5^{0}K. There had been concerns that the plasma pulses and pulsed magnetic fields might cause a "quench" in the HTS, i.e. a sudden and potentially damaging transition from superconductor to normal conductor. However, many plasma pulses were fired without any quenches. No quench has been observed at DC currents up to 250A during bench tests. In the AC tests, current up to 1kA through the tape (6kA-turns through the coil) has been achieved with no degradation of the HTS performance afterwards and the rate of the current ramp in the HTS coil ~0.6MA/s has been achieved. In future experiments, increases in both the plasma current and pulse duration are planned. Considerable experience has been gained during design and fabrication of the cryostat, coils, isolation and insulation, feeds and cryosystems. The tokamak GOLEM is now routinely operated with HTS coils. The construction of a small fully-HTS low aspect ratio tokamak has started at the Tokamak Solutions UK premises in the Culham Science Centre and first results will be presented.