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Entanglement in a Solid State Spin Ensemble STEPHANIE SIMMONS, RICHARD BROWN, Oxford University, HELGE RIEMANN, NIKOLAI ABROSIMOV, Leibniz Institut, PETER BECKER, PTB Braunschweig, HANS-JOACHIM POHL, VITCON Projectconsult GmbH, MIKE THEWALT, Simon Fraser University, KOHEI ITOH, Keio University, JOHN MORTON, Oxford University — Entanglement is a both a fascinating phenomenon and a critical ingredient in most emerging quantum technologies. Spin ensembles manipulated using magnetic resonance have demonstrated the most advanced quantum algorithms to date, however these studies contain no entanglement and hence constitute classical simulations of quantum algorithms. Here we report the on-demand generation of entanglement between an ensemble of electron and nuclear spins in isotopically engineered phosphorus-doped silicon. High field/low temperature electron spin resonance (3.4 T, 2.9 K) was used in conjunction with a hyperpolarisation sequence to reduce the spin entropy to a level sufficient to form an inseparable state. The generated entanglement was confirmed by measuring the state's density matrix which displayed a fidelity of 98% compared to the ideal state at this field and temperature. The entanglement operation was performed simultaneously, with high fidelity, to 10^{10} spin pairs, and represents an essential requirement of a silicon- based quantum information processor.

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