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Pulsed Electron Spin Resonance Quantum Information Processing with Stable Organic Free-Radical Spin Samples TROY BORNEMAN, OLAF BENNINGSHOF, HAMID MOHEBBI, MOHAMAD NIKNAM, IVAR TAMINIAU, CHRISTOPHER WOOD, DANIEL PUZZUOLI, DAVID CORY, University of Waterloo — Nuclear magnetic resonance (NMR) has served as an important tool for evaluating control methods in large Hilbert spaces that may be applied to a wide-range of systems for quantum information processing (QIP). The weak interaction of nuclear spins with their environment provides long coherence times, but also increases the difficulty of scaling NMR QIP systems to many qubits. By appending an electron spin, in the form of a stable free-radical, to a nuclear spin register, consisting of atomic nuclei in organic molecules, the potential for enhanced scalability is obtained. Fast quantum gates on the nuclear spins may be performed by pulsed electron spin resonance (ESR) manipulation of the electrons only. The electrons also enable the preparation of highly-pure processor states and the application of convenient quantum error correction. We present new results on performing pulsed ESR QIP with solid-state thin film samples of organic free-radicals integrated with superconducting electronics. A high quality factor superconducting microstrip resonator operating at X-band (10 GHz) frequencies provides sufficient sensitivity to investigate molecular monolayer samples. The resonator may also be used as a thermal bath to efficiently remove entropy from the electron-nuclear spin system.

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