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Stochastic atomistic disorder in atomic-precision doping

E. Bussmann, J.A. Ivie, J. Koepke, Q. Campbell, M.I. Brickson, P.A. Schultz, R.P. Muller, A.D. Baczewski, A. Mounce, S. Misra

Atomic-precision advanced manufacturing (APAM) enables the near-deterministic placement of single donors with near-atomic precision, which has been used to produce surprising device demonstrations, e.g. the single-atom transistor. However, APAM incorporates dopants into silicon using surface chemistry, where competing chemical processes lead to stochastic outcomes. Through statistical studies on arrays of nominally identical structures ranging down to single-atom features, we have measured the probability to achieve desired target outcomes for few and single-atom structures. Significant variability is measured in single- and few-donor structures. For example, we find a success rate of 68% for single-donor sites. We will explain how the results pose a significant challenge for engineering future quantum simulators and circuits.

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