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Silicon qubit performance in the presence of inhomogeneous strain[1] N. TOBIAS JACOBSON, DANIEL R. WARD, ANDREW D. BACZEWSKI, JOHN K. GAMBLE, INES MONTANO, MARTIN RUDOLPH, ERIK NIELSEN, MALCOLM CARROLL, Sandia National Laboratories — While gate electrode voltages largely define the potential landscape experienced by electrons in quantum dot (QD) devices, mechanical strain also plays a role. Inhomogeneous strain established over the course of device fabrication, followed by mismatched contraction under cooling to cryogenic temperatures, may significantly perturb this potential. A recent investigation by Thorbeck Zimmerman [AIP Adv. 5, 087107 (2015)] suggests that unintentional QDs may form as a result of the latter thermal contraction mismatch mechanism. In this work, we investigate the effects of inhomogeneous strain on QD tunnel barriers and other properties, from the perspective of QD and donor-based qubit performance. Through semiconductor process simulation, we estimate the relative magnitude of strain established during fabrication as compared with thermal expansion coefficient mismatch. Combining these predictions with multi-valley effective mass theory modeling of qubit characteristics, we identify whether strain effects may compel stricter than expected constraints on device dimensions. Finally, we investigate the degree to which strain and charge disorder effects may be distinguished.

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