Isotopically Enriched 28-Silicon for Quantum Technologies

Richard J Curry
Ravi Acharya, Maddison Coke, Mason Adshead, Kexue Li, Barat Achinuq, Rongsheng Cai, A. Baset Gholizadeh, Janet Jacobs, Jessica L. Boland, Sarah J. Haigh, Katie L. Moore, David N. Jamieson

Department of Electrical and Electronic Engineering, Photon Science Institute, University of Manchester, Manchester, M13 9PL, UK

richard.curry@manchester.ac.uk

Abstract

The development of solid-state platforms for quantum computing have received significant attention due to their potential to enable scaling to large (e.g. 1 million) qubit systems. Of these, silicon is attractive due to the established highly mature microfabrication processing technology which can be leveraged to realise future quantum technologies.
A key challenge which has limited the performance of silicon-based qubits is the presence of the naturally occurring 29-silicon isotope with an abundance of 4.7%. This leads to nuclear spin flip-flopping which diffuses throughout the silicon and causes decoherence of qubits formed within the same volume. It has been shown that reducing the 29-silicon to 800 ppm can improve the electron pure dephasing time (T_{2e*}) by a factor of 5000 [1].
In this work we report an update on our work to produce isotopically enriched 28-silicon for use in quantum technologies (Figure 1) [2]. Using the Platform for Nanoscale Advanced Materials Engineering (Figure 2) [3] we demonstrate the fabrication of enriched 28-silicon volumes with a background 29-silicon population of ~2 ppm. These regions can be doped with impurity ions for qubit fabrication, with their electronic activation occurring during epitaxial regrowth of the single crystal silicon substrate.

References

[1] Muhonen, J. T. et al. Nat. Nanotechnol. **9** (2014) 986–991.
[2] Archarya, R. et al. Communications Materials **5** (2024) 57.
[3] Adshead, M. et al. Adv. Eng. Mater. **25** (2023) 2300889.

Figures

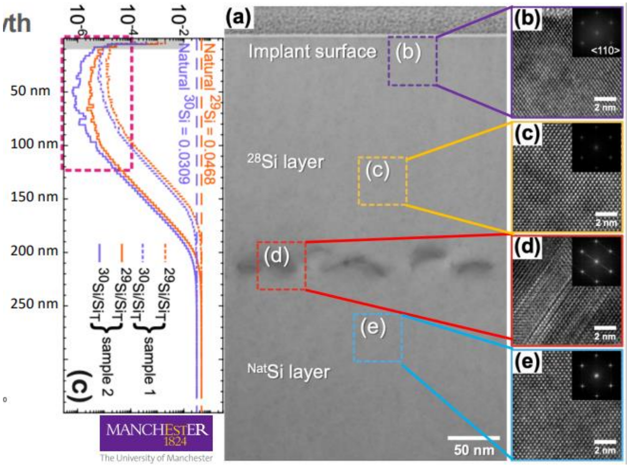

Figure 1: NanoSIMS profile (left) of 29-silicon and 30-silicon concentration aligned with HR-TEM image of enriched sample (right).

Figure 2: Platform for Nanoscale Advanced Materials Engineering.