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Remarkable linewidth improvements for well-known radiation damage centres in highly enriched 28Si

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A multitude of radiation damage centers in Si with highly reproducible optical emission and absorption lines have been studied exhaustively using a wide variety of techniques over the past 50+ years. Some of these centers produce very bright luminescence, and have recently received renewed interest as possible light emitters, and single photon sources, compatible with an integrated silicon photonic technology. Previous high resolution studies of these centers in natural Si have shown reproducible limiting linewidths of typically no better than 0.04 meV, and it has become widely assumed that these relatively narrow linewidths represent some kind of fundamental limit for these centers.

We show [1] that these linewidths in fact result from inhomogeneous broadening due to the mixed isotopes present in natural silicon, and that the linewidths observed for ensembles of these defects in highly isotopically enriched 28Si can be over two orders of magnitude narrower. We report results for the W line, which emits at 1218 nm, the G line which emits at 1279 nm, and the C line which emits at 1570 nm, all near important telecommunication bands. Not only do these emission lines become dramatically narrower in 28Si, in some cases less than the 0.25 μeV limiting resolution of our spectrometer, but for one of these centers fine structure is revealed which is hidden in ensemble spectra from natural Si. These results have direct implications for the spectral widths and fine structure to be expected from individual emitters, even in natural Si.

[1] C. Chartrand, L. Bergeron, K. J. Morse, H. Riemann, N. V. Abrosimov, P. Becker, H.-J. Pohl, S. Simmons, and M. L. W. Thewalt, Highly enriched 28Si reveals remarkable optical linewidths and fine structure for well-known damage centers. Physical Review B 98, 195201 (2018).

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