Strain Enhancement of Electron Cooling in Silicon-Superconductor Tunnel Junctions

M. J. Prest[a], J. T. Muhonen[b], M. Prunnila[c], D. Gunnarsson[c], **J. S. Richardson-Bullock**[a], V. A. Shah[a], R. J. H. Morris[a], A. Dobbie[a], M. Myronov[a], T. E. Whall[a], E. H. C. Parker[a], and D. R. Leadley[a]

[a]Department of Physics, University of Warwick, Coventry, CV4 7AL, United Kingdom
[b]Low Temperature Laboratory, Aalto University, POB 13500, FI-00076 AALTO, Finland
[c]VTT Research Centre, Espoo, Helsinki, Finland

The silicon-superconductor tunnel junction is analogous to the normal metal-insulator-superconductor (NIS) tunnel junction; it has been previously demonstrated that the normal metal in an NIS cooler can be replaced with a degenerate semiconductor and that an insulating tunnel junction is formed by a Schottky barrier. We have shown that the electron-phonon (e-ph) conductance is reduced when silicon is subjected to biaxial tensile strain and is approximately an order of magnitude lower than that of unstrained silicon.[1] In this work we show that the reduced e-ph conductance results in enhanced electron cooling; we demostrate cooling to 174 mK from an initial bath temperature of 300 mK. We argue that broadening of the superconductor density of states is responsible for limitation of the cooler performance.

[1]J. T. Muhonen, M. J. Prest, M. Prunnila, D. Gunnarsson, V. A. Shah, R. J. H. Morris, A. Dobbie, M. Myronov, T. E. Whall, E. H. C. Parker and D. R. Leadley, to be published Applied Physics Letters (2011).