Supplementary Material for: "Supercurrent in ferromagnetic Josephson junctions with heavy metal interlayers" by N. Satchell and N. O. Birge

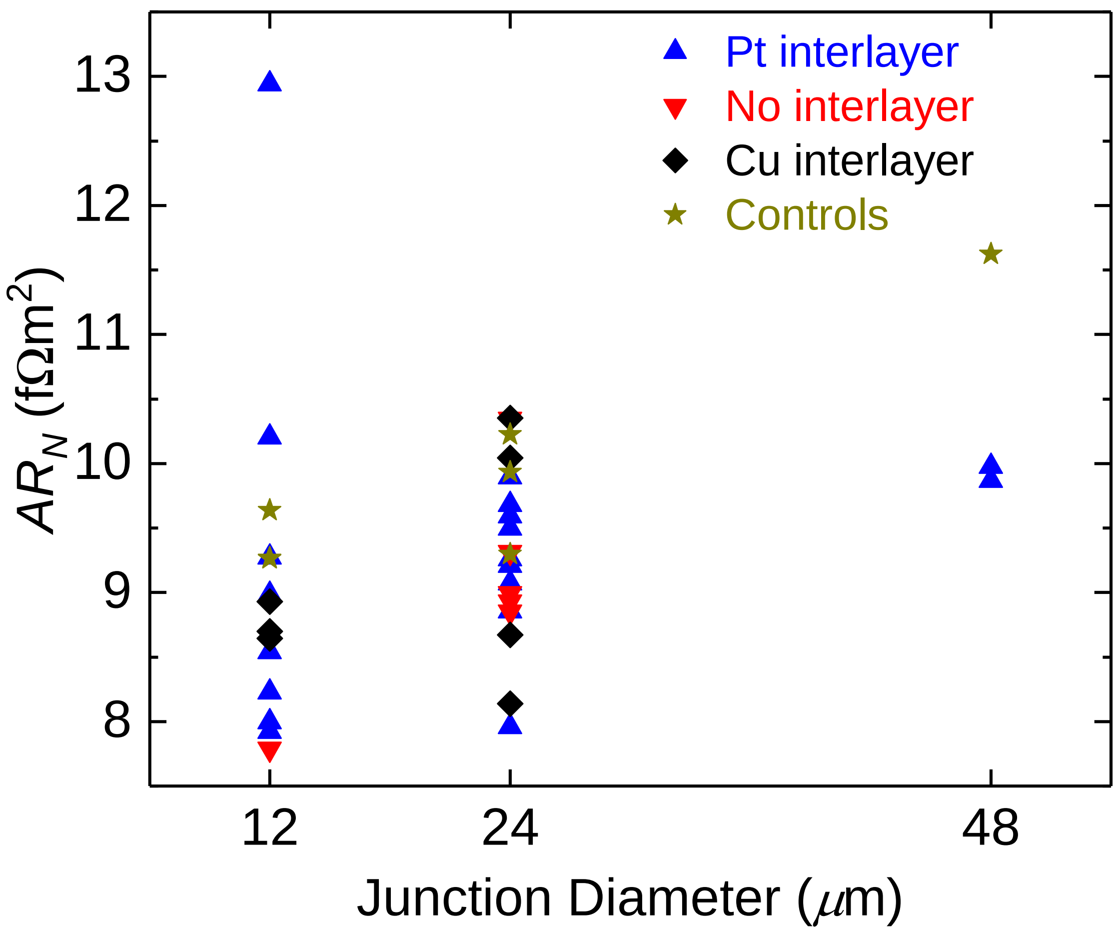

FIG. 1. The area-resistance product with junction diameter for all Josephson junctions presented in the main text. The symbols are chosen to match those used in figures in the main text. The small variation in AR_N indicates that sample-to-sample fabrication reproducibility is very high in this study.

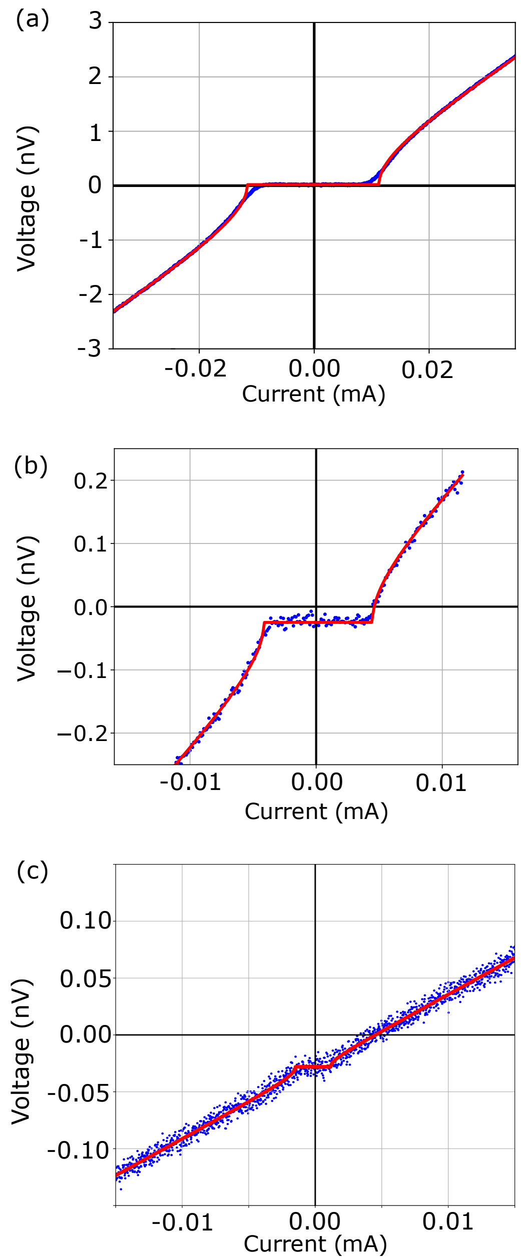

FIG. 2. Representative current-voltage curves. Data (blue points) are fitted using the square root function (red lines) to determine I_c. (a) Data acquired on a 12μm diameter Josephson junction with structure S–Pt(0.5)–Co(5)/Ru(0.6)/Co(5)–Pt(0.5)–S at 0 Oe applied field. (b) Data acquired on a 24μm diameter Josephson junction with structure S–Co(4)/Ru(0.6)/Co(4)–S at -2 Oe applied field. And (c) data acquired on a 48μm diameter Josephson junction with asymmetric structure S–Co(5)/Ru(0.6)/Co(5)–Pt(0.5)–S at 0 Oe applied field.

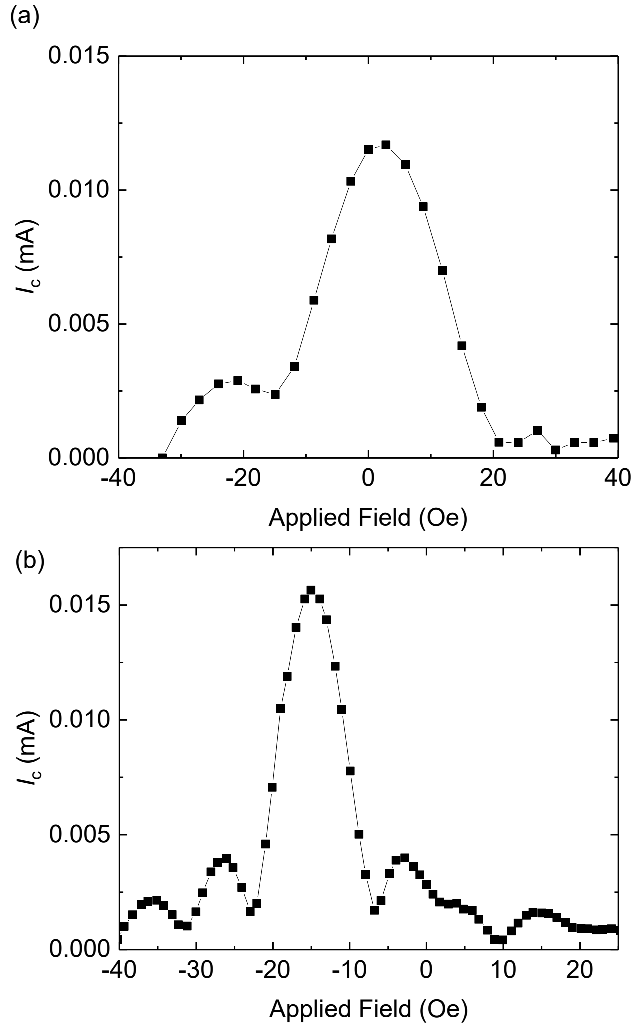

FIG. 3. The critical current, I_c, is plotted vs the applied in-plane field for the representative samples (a) a 12μm diameter Josephson junction with structure S–Pt(0.5)–Co(5)/Ru(0.6)/Co(5)–Pt(0.5)–S. And (b) a 24μm diameter Josephson junction with asymmetric structure S–Pt(0.5)–Co(5)/Ru(0.6)/Co(5)–S. Lines through the data are a guide for the eye.

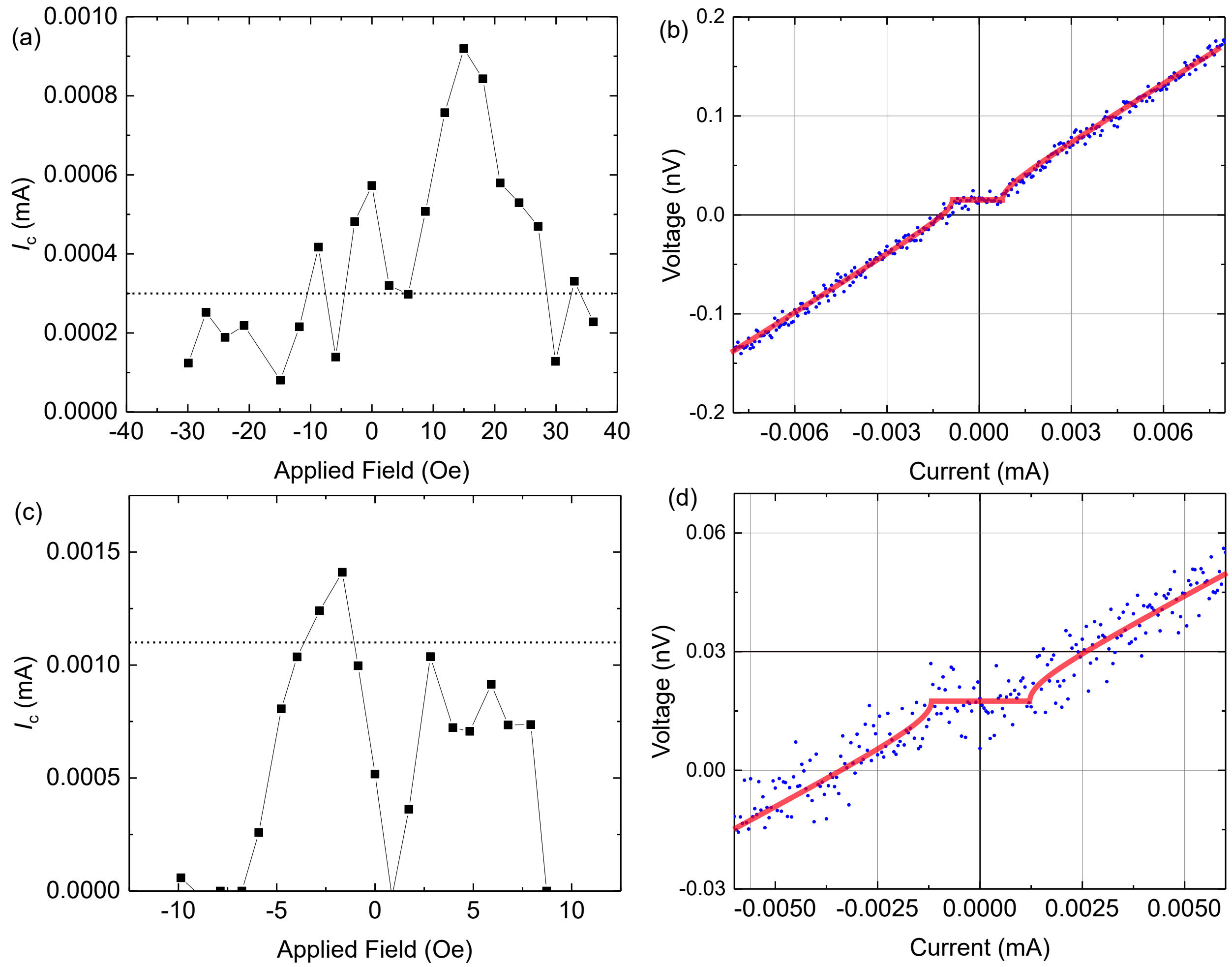

FIG. 4. Data acquired on the (a,b) $d_{\text{Co}} = 20$ nm and (c,d) $d_{\text{Co}} = 24$ nm samples described in the main text. (a) The critical current, I_c, is plotted vs the applied in-plane field for a $d_{\text{Co}} = 20$ nm, 24 μm diameter Josephson junction. A clear peak in I_c is observed, centered at applied field 13 Oe. The current-voltage curve at 13 Oe is plotted in (b) along with the square root fit to the data. The square root fit returns $\chi^2 = 339$ for 321 data points, while a straight line fit to the same data (not shown) returns $\chi^2 = 533$. (c) The critical current, I_c, is plotted vs the applied in-plane field for a $d_{\text{Co}} = 24$ nm, 48 μm diameter Josephson junction. This sample does not produce a clear peak in $I_c(H)$. The current-voltage curve for this sample at -2 Oe is plotted in (d) along with the square root fit to the data. The square root fit returns $\chi^2 = 247$ for 242 data points, while a straight line fit to the same data (not shown) returns $\chi^2 = 285$. The dashed horizonatal line in (a,c) represents the approximate resolution of our instrument in determining I_cR_N (6 pV) and lines connecting data points are as a guide for the eye.

TABLE I. In this table we compare the decay length inside the Co layer of our Josephson junctions to the previous work of Khasawneh, *et al.* *Phys. Rev. B* **80**, 020506(R) (2009). It is found that the decay length in the absence of any additional interlayers in this work is longer than that reported by Khasawneh, *et al.* however the Pt interlayers do not recover as long a decay length as found in the previous samples with Cu interlayers.

Sample	**Co decay length**	**Source**
$[Nb(25)/Al(2.4)]_{x3}/Nb(20)/Co(d_{Co}/2)$ $/Ru(0.6)/Co(d_{Co}/2)/Nb(5)/Au(15)$	1.7 ± 0.2 nm	This work
$[Nb(25)/Al(2.4)]_{x3}/Nb(20)/Pt(0.5)/Co(d_{Co}/2)$ $/Ru(0.6)/Co(d_{Co}/2)/Pt(0.5)/Nb(5)/Au(15)$	1.73 ± 0.07 nm	This work
$Nb(150)/Co(d_{Co}/2)/Ru(0.6)/$ $Co(d_{Co}/2)/Nb(25)/Au(15)$	1.18 ± 0.05 nm	Khasawneh, *et al.*
$Nb(150)/Cu(5)/Co(d_{Co}/2)/Ru(0.6)/$ $Co(d_{Co}/2)/Cu(5)/Nb(25)/Au(15)$	2.34 ± 0.08 nm	Khasawneh, *et al.*

TABLE II. In this table we compare the I_cR_N values for a total Co thickness of 10 nm for our Josephson junctions to the previous work of Khasawneh, *et al.* *Phys. Rev. B* **80**, 020506(R) (2009). It is found that for all comparable samples the I_cR_N values in this work are about an order of magnitude lower than those found in the previous work.

Sample	I_cR_N **(nV)**	**Source**
Nb(150)/Co(5)/Ru(0.6)/Co(5)/Nb(25)/Au(15)	0.502 ± 0.05	Khasawneh, *et al.*
$[Nb(25)/Al(2.4)]_{x3}/Nb(20)/Co(5)/Ru(0.6)/Co(5)/$ /Nb(5)/Au(15)	0.0552 - 0.0810	This work
Nb(150)/Cu(5)/Co(5)/Ru(0.6)/Co(5)/Cu(5)/Nb(25)/Au(15)	9.24 ± 1	Khasawneh, *et al.*
$[Nb(25)/Al(2.4)]_{x3}/Nb(20)/Cu(2.5)/Co(5)/Ru(0.6)/Co(5)/$ Cu(2.5)/Nb(5)/Au(15)	0.603 - 0.725	This work
$[Nb(25)/Al(2.4)]_{x3}/Nb(20)/Pt(0.5)/Co(5)/Ru(0.6)/Co(5)/$ Pt(0.5)/Nb(5)/Au(15)	0.823 - 0.938	This work