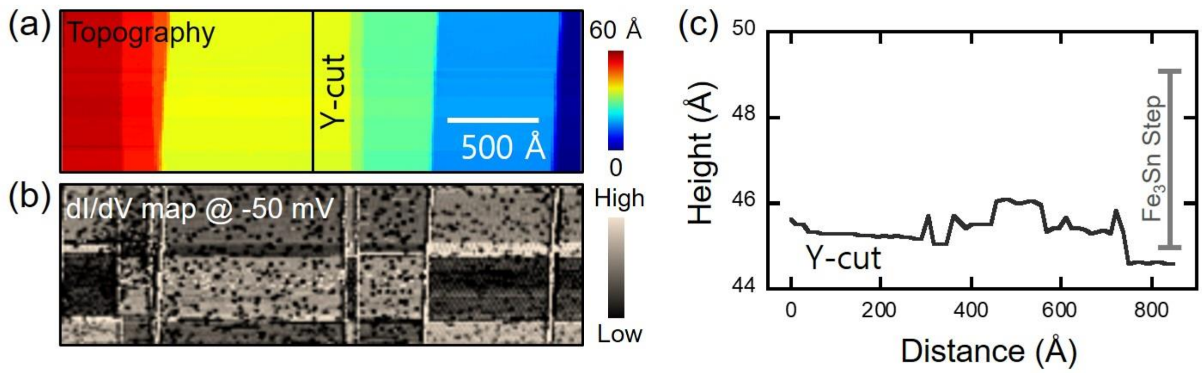
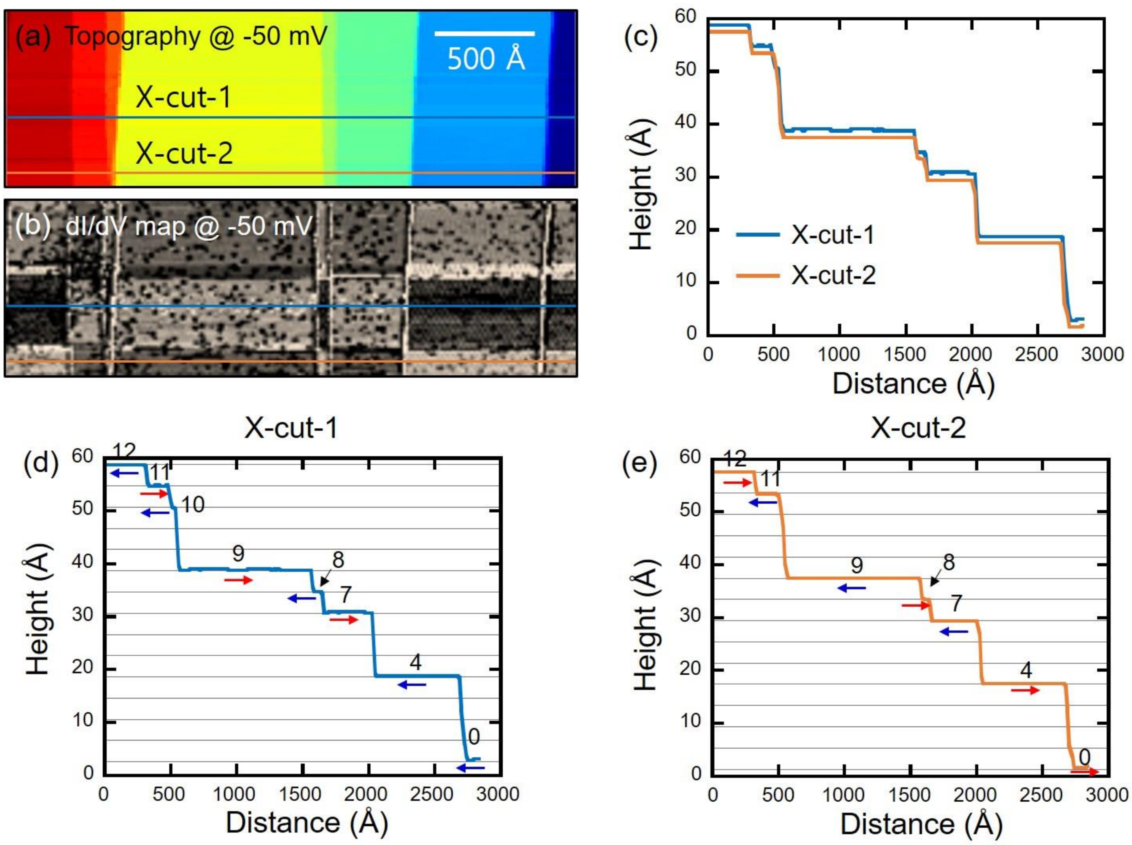
Supplementary Information

Spin-polarized and possible pseudospin-polarized scanning tunneling microscopy in kagome metal FeSn

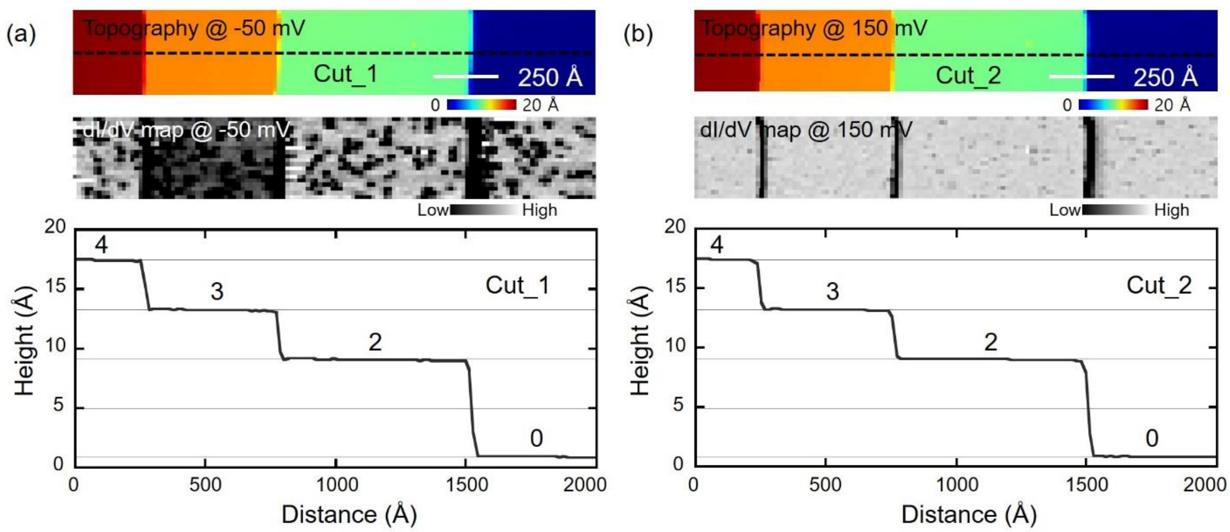
[1]Department of Emerging Materials Science, Daegu Gyeongbuk Institute of Science & Technology (DGIST), Daegu 42988, Republic of Korea
[2]DGIST Research Institute, Daegu Gyeongbuk Institute of Science & Technology (DGIST), Daegu 42988, Republic of Korea
[3]Department of Interdisciplinary Engineering, Daegu Gyeongbuk Institute of Science & Technology (DGIST), Daegu 42988, Republic of Korea
[+]These authors contributed equally
[*]The correspondence should be addressed to keeseong@dgist.ac.kr or jdlee@dgist.ac.kr or jseo@dgist.ac.kr



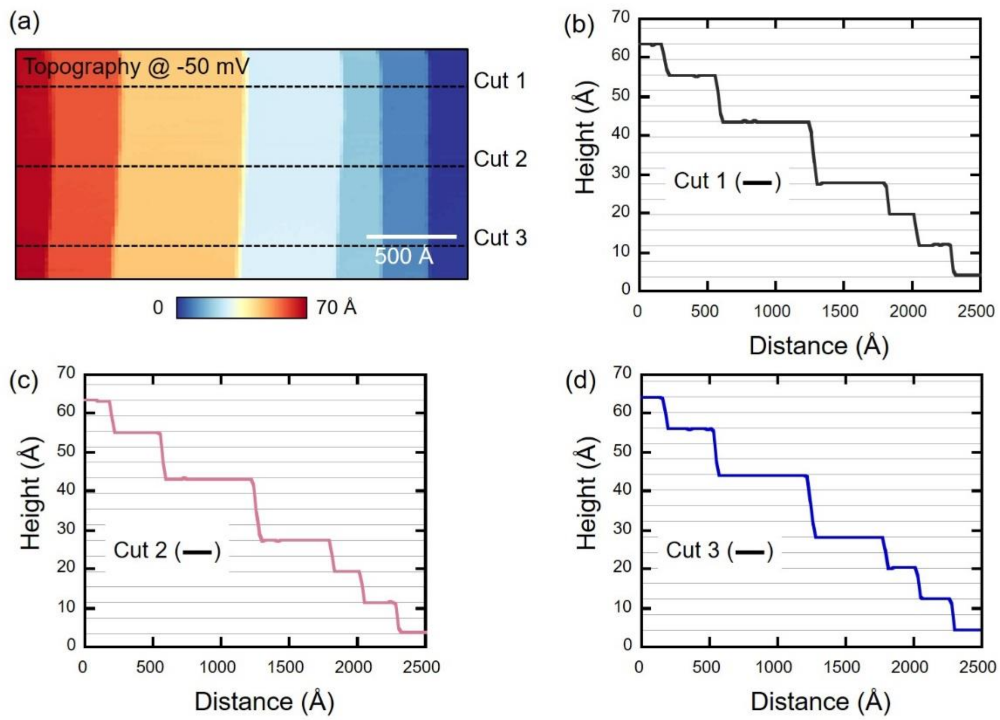
Supplementary Figure 1 Spin contrast changes depending on the tip spin. (a) Topography and (b) dI/dV map measured at V_{bias} = -50 mV and I_t = 3 nA. The contrast difference is reversed by tip spin changes. (c) The line profile taken along ‘Y-cut’ in (a). Since Fe_3Sn layers are antiferromagnetically coupled, the tip spin cannot change for the Fe_3Sn-terminated tip. Nevertheless, the tip can pick up tiny magnetic particles (Fe atoms) when scratching the step edges during scanning under harsh tunneling condition. The line profile actually shows that the tiny particles much smaller than the Fe_3Sn step height is rolling on the tip. Such particles are unstable, and the spin can be changed by further touching step edges.



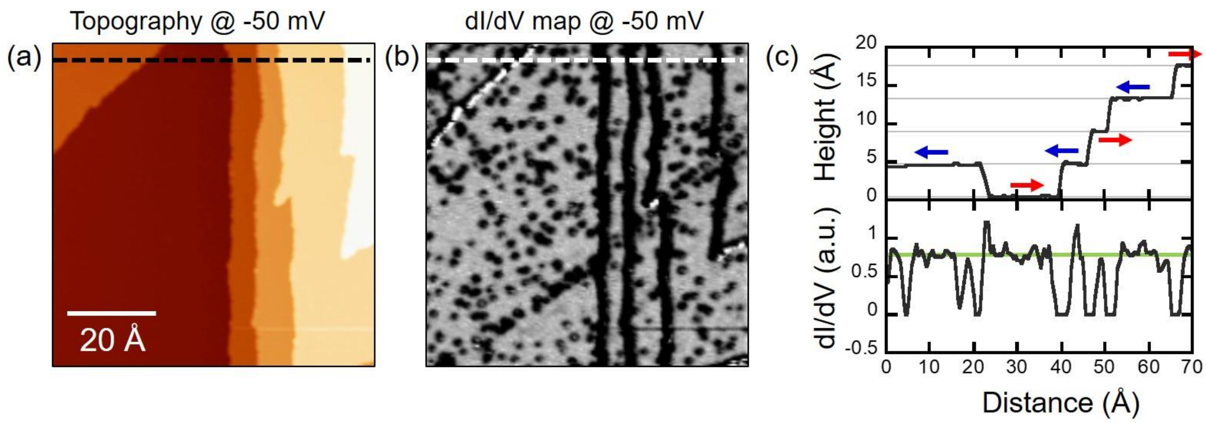
Supplementary Figure 2 Line profiles taken across the terraces in Fig. S2. (a) Topography measured at -50 mV. (b) Simultaneously obtained dI/dV map. I_t = 3 nA and V_{mod} = 10 mV_{pp}. (c) Height profiles taken along X-cut-1 and X-cut-2 in (a). The offset between the two profiles is due to the tip change shown in Fig. R1. (d,e) Assignment of step heights and spin orientations on the terraces. The effect of spin-polarization is negligible on counting the step heights. The grid spacing represents the single-step height of Fe_3Sn layer.



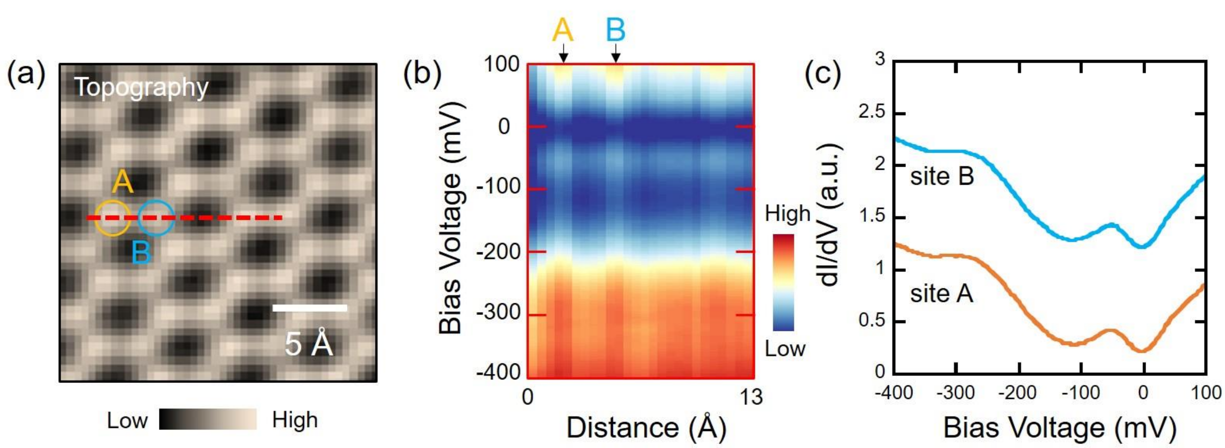
Supplementary Figure 3 SPSTM image depending on the bias voltage. (a) Topography and corresponding *dI/dV* map measured at V_{bias} = -50 mV, I_t = 100 pA and V_{mod} = 10 mV_{pp}. The spin-polarized signal is observed in the *dI/dV* map. The height profile is taken along Cut_1 in the topography. (b) Same data set measured at V_{bias} = 150 mV. At this bias voltage, the spin-polarization is minimized. The height profile is taken along Cut_2. By comparing the two height profiles, we can see that the spin-polarized signal has no significant effect on calculating the number of terrace heights. The grid spacing represents the single-step height of Fe_3Sn layer.



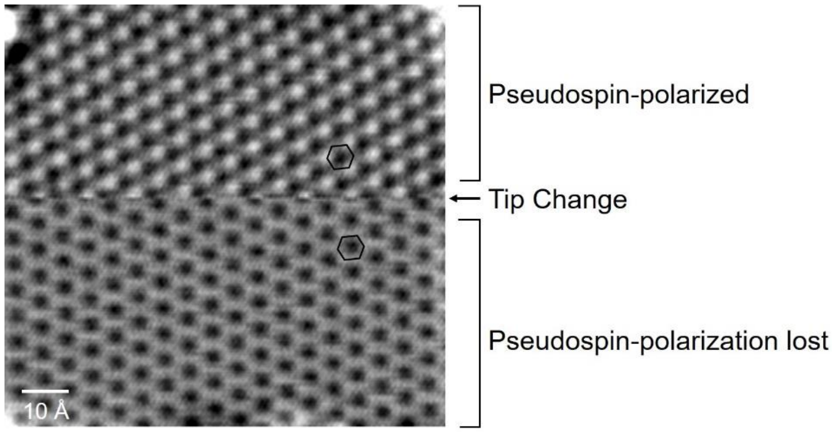
Supplementary Figure 4 Height profiles along several horizontal lines in Fig. 2c of main text. (a) Three horizontal lines along which the height profiles are taken. (b-d) The Height profiles. The grid spacing represents the single-step height of Fe_3Sn layer.



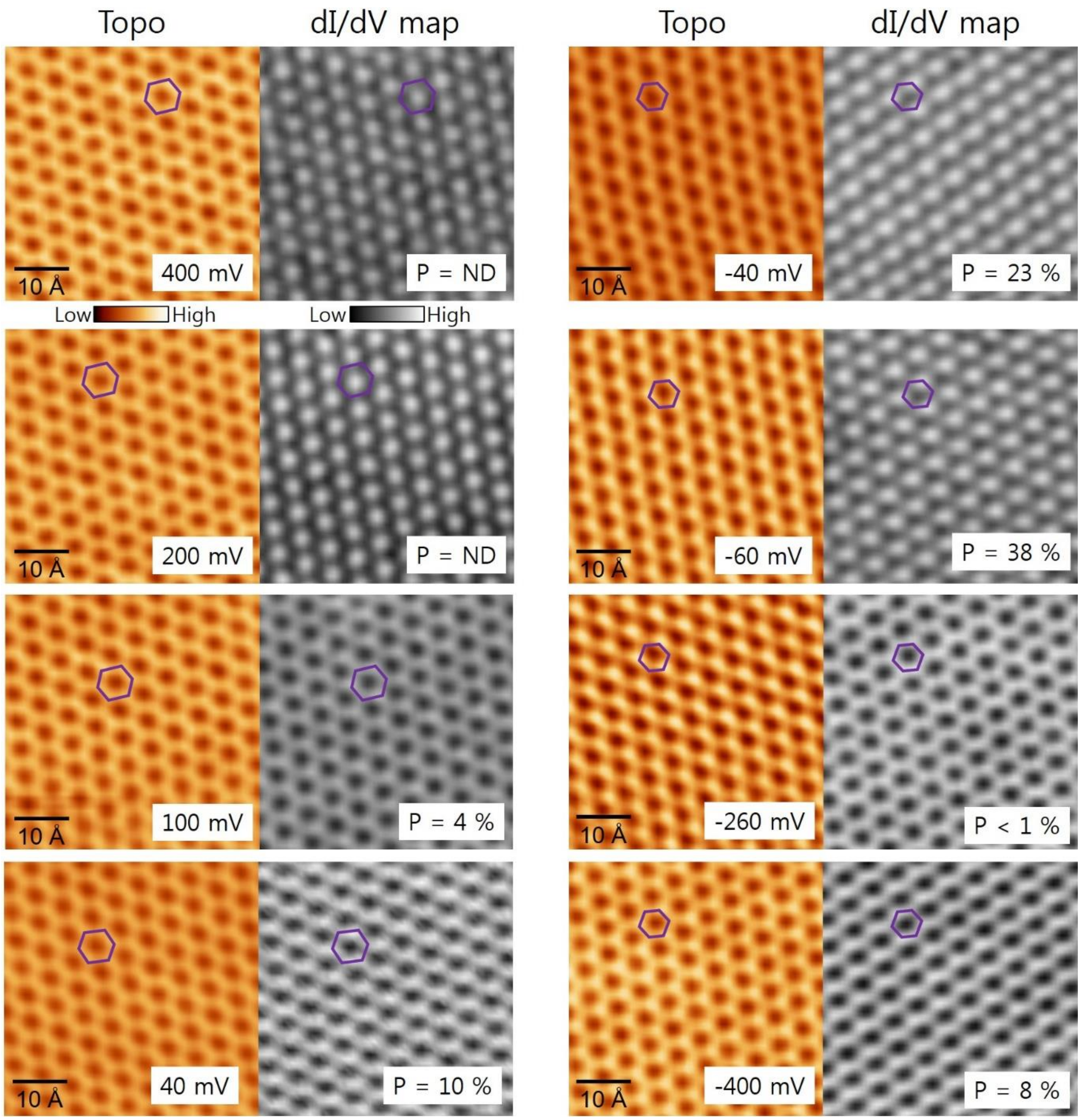
Supplementary Figure 5 *dI/dV* map measured with a clean tip. (a) Topography measured with V_{bias} = -50 mV, I_t = 200 pA, and V_{mod} = 10 mV_{pp}. (b) Simultaneously obtained *dI/dV* map. (c) Height and *dI/dV* intensity profiles taken along the dashed lines in (a) and (b). The grid spacing in the top panel represents the single-step height of Fe_3Sn layer. The green line in the bottom panel indicates the level of the *dI/dV* intensity at the terraces. When a clean tip is used, no spin-polarized signal is observed in the *dI/dV* map.



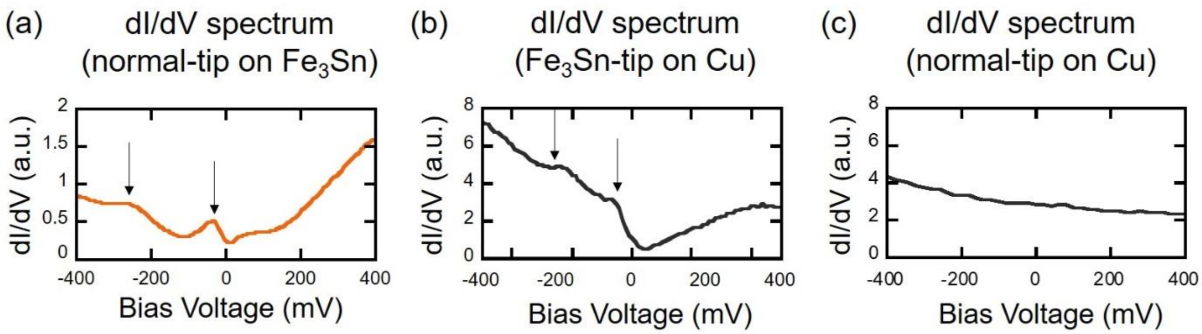
Supplementary Figure 6 Site-dependent *dI/dV* spectra measured with a clean tip. (a) Topography of Fe_3Sn measured using a clean tip. V_{bias} = -50 mV and I_t = 100 pA. 'A' and 'B' represent the down-triangle and up-triangle sites of the Kagome lattice, respectively. (b) dI/dV spectra measured along the dashed line in (a). V_{bias} = -400 mV, I_t = 200 pA and V_{mod} = 10 mV_{pp}. (c) *dI/dV* spectra measured at the site A and site B. No essential difference exists between the *dI/dV* spectra.



Supplementary Figure 7 Lost of pseudospin polarization by a tip change. *dI/dV* map measured at V_{bias} = -40 mV, I_t = 1 nA and V_{mod}= 10 mV_{pp}. The pseudospin polarization is lost when the tip is changed.



Supplementary Figure 8 Pseudospin-polarization depending on bias voltage. Left panels are topographic images and right panels are simultaneously obtained *dI/dV* maps. The purple hexagons are given for the comparison between the topographic images and the *dI/dV* maps. The tip is pseudospin-polarized by the termination of Fe3Sn layers. The intensities of the *dI/dV* maps represent the pseudospin configurations of the sample. When the sample pseudospin is parallel to the tip pseudospin, the intensity is high (I_{high}). When the pseudospins are antiparallel, the intensity is low (I_{low}). The intensity is measured referenced to the intensity at the center of hexagon. The pseudospin-polarization is calculated by $P = [I_{high} - I_{low}]/[I_{high} + I_{low}]$. The pseudospin-polarization is not determined (ND) at the bias voltages of 400 mV and 200 mV because the Sn atoms dominate the intensity of the dI/dV maps and the Kagome lattices are not resolved.



Supplementary Figure 9 Characterization of Fe_3Sn-terminated tip on Cu(111). (a*) dI/dV* spectrum measured on Fe_3Sn surface using a clean tip. The vertical arrows indicate the characteristic peaks of Fe_3Sn. V_{bias} = -400 mV, I_t = 200 pA and V_{mod} = 10 mV_{pp}. (b) *dI/dV* spectrum measured on Cu(111) using the indented tip in FeSn. The peaks of Fe_3Sn are observed, suggesting that the tip is Fe_3Sn-terminated. (c) *dI/dV* spectrum measured on Cu(111) using a clean tip.