

Erratum: "Electrodeposition of Cu(111) onto a Ru(0001) Seed Layer for Epitaxial Cu Interconnects" J. Appl. Phys. 130, 135301 (2021)

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The corrections and the corrected figures are given below.

1. Abstract: “compressive misfit strain between -6.9% and -8.3% ” should be replaced with “tensile misfit strain between 5.9 and 7.4% ”.
2. Introduction: “compressive misfit strain of up to -8.3% ” should be replaced with “tensile misfit strain of up to 7.4% ”.
3. Methodology: “ $\{11\bar{2}0\}$ planes of the sapphire, thus, the $\{10\bar{1}0\}$ planes of Ru” should be replaced with “ $\{10\bar{1}0\}$ planes of the sapphire, thus, the $\{11\bar{2}0\}$ planes of Ru”.
4. Section III.A:
 - “ $\text{Cu}[1\bar{1}0] \parallel \text{Ru}[11\bar{2}0]$ ” should be replaced with “ $\text{Cu}[1\bar{1}0] \parallel \text{Ru}[11\bar{2}0]$ ”.
 - “parallel to the prismatic planes, $\{10\bar{1}0\}$, of Ru” should be replaced with “parallel to $\{11\bar{2}0\}$ planes of Ru”.
 - “For every one $\{10\bar{1}0\}$ plane of Ru, there are two $\{2\bar{2}0\}$ planes of Cu.” should be replaced with “For every one $\{11\bar{2}0\}$ plane of Ru, there is one $\{2\bar{2}0\}$ plane of Cu.”
 - Equation 5 should be replaced with the following:

$$\varepsilon_{\text{Cu/Ru}} = \frac{d_{11\bar{2}0}^{\text{Ru}} - d_{2\bar{2}0}^{\text{Cu}}}{d_{2\bar{2}0}^{\text{Cu}}}.$$

- “ -8.3% and -6.9% ” should be replaced with “ 5.9% and 7.4% ”.
- “compression” should be replaced with “tension”.
- The following sentence should be deleted: “This method is incorrect and places the Cu layer in tension with the seed layer rather than compression”.
- Figure 1 should be replaced with the following:

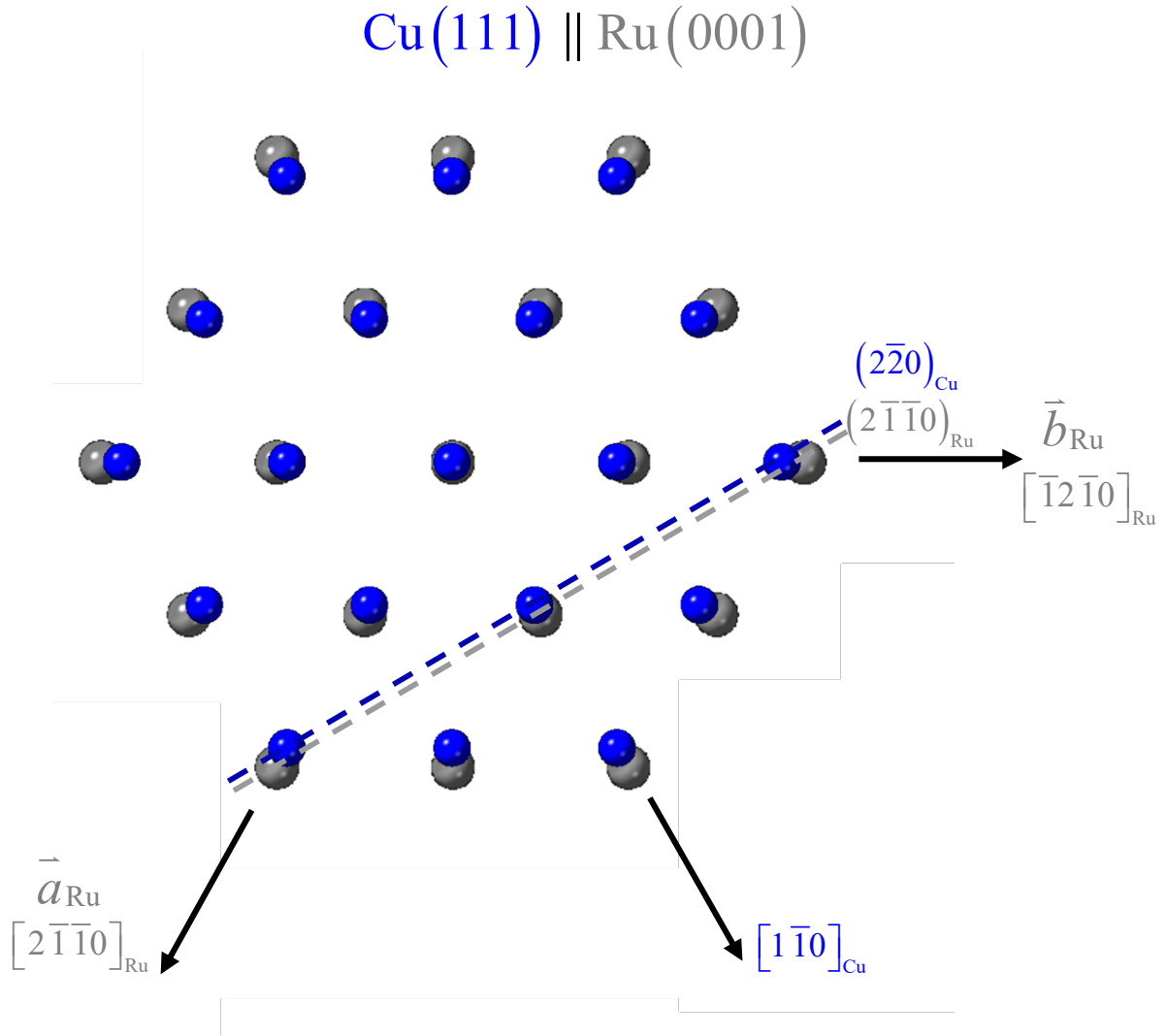


FIG. 1. Schematic representation of the epitaxial orientation relationship between $\text{Cu}(111)$ and $\text{Ru}(0001)$. The unit cell of Ru is defined by placing a Ru atom at the origin $(0,0,0)$.

5. Section III.C:

- Figure 5 should be replaced with the following:

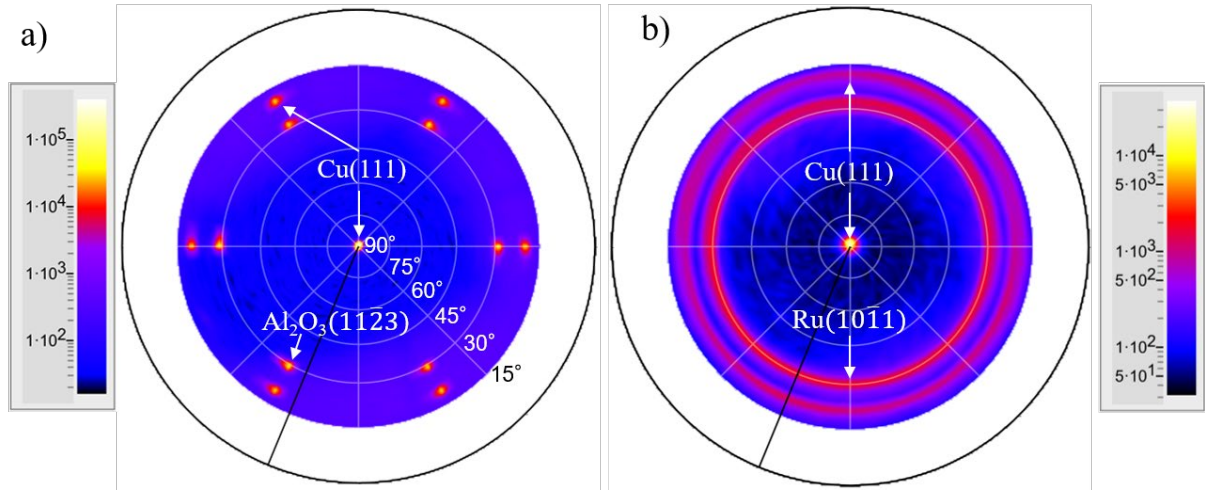


FIG. 5 – Pole figures of Cu electrodeposited onto (a) 30 nm Ru(0001) / Al₂O₃(0001) and (b) 100 nm polycrystalline Ru / 4 nm TaN / SiO₂ / Si seed layers at -350 μ A/cm² for 1200 seconds from solutions of 2 mM CuSO₄, 0.5 M H₂SO₄, and 1.41 mM KCl. The scale for α is provided in (a). Both PFs were obtained at a fixed 2θ of 43.34°, which was determined to be the peak position of the (111) reflection of Cu. The Cu films were electrodeposited onto a stationary Ru coupon with solution agitation provided by a magnetic stir bar rotating at 150 RPM.

- “The inner-most reflection spots with $\alpha = 29.1^\circ$ are from the $\{10\bar{1}1\}$ family of planes for Ru ($2\theta_B = 44.22^\circ$ and $\alpha = 28.7^\circ$)” should be replaced with “The inner-most reflection spots with $\alpha = 28.8^\circ$ are from the $\{11\bar{2}3\}$ family of planes for sapphire ($2\theta_B = 43.35^\circ$ and $\alpha = 28.8^\circ$).”
- The following sentence should be deleted: “The six spots clearly display the six-fold symmetry of hexagonal Ru.”
- “Cu($1\bar{1}0$)||Ru($\{10\bar{1}0\}$)” should be replaced with “Cu($2\bar{2}0$)||Ru($2\bar{1}\bar{1}0$)”.

6. Section III.D:

- Figure 11 should be replaced with the following. In the caption “[10 $\bar{1}0$]” should be replaced with “[11 $\bar{2}0$]”.
- In the caption of Figure 12, “[10 $\bar{1}0$]” should be replaced with “[11 $\bar{2}0$]”.

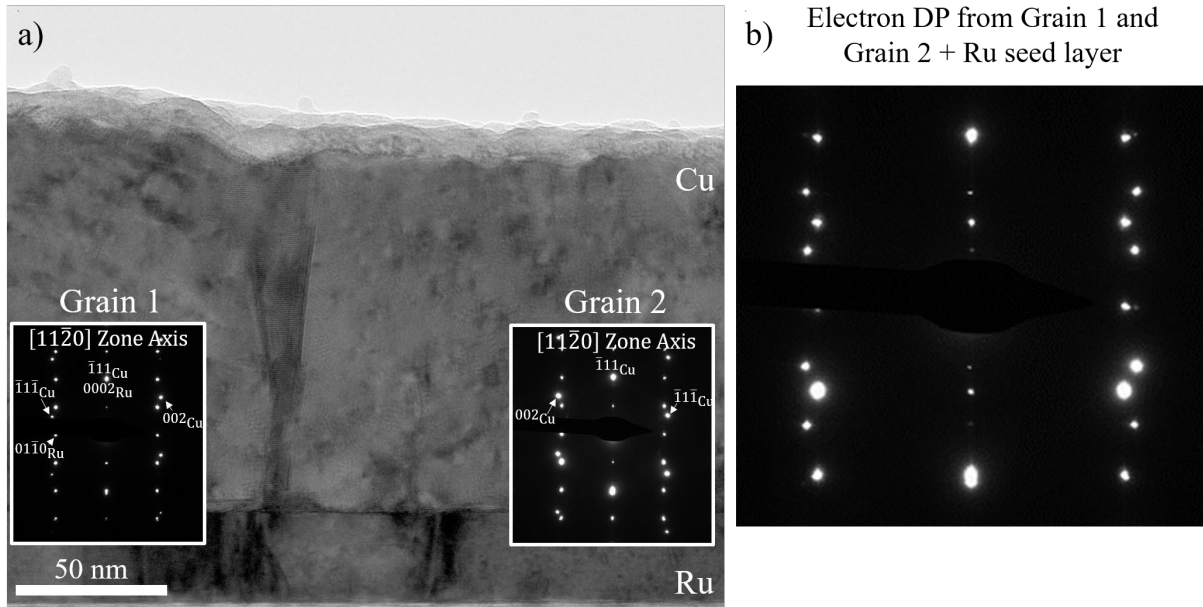


FIG. 11 – (a) Phase contrast transmission electron micrograph acquired on the $[11\bar{2}0]$ zone axis of the 30 nm-thick Ru(0001) seed layer, which is the $[1\bar{1}0]$ zone axis of Cu, with electron diffraction patterns (DPs) from the Ru seed layer and Cu Grain 1 or Grain 2 (inset) and (b) electron DP pattern from entire Cu layer and Ru seed layer. The Cu layer was electrodeposited at $-350 \mu\text{A}/\text{cm}^2$ for 1200 seconds from solutions of 2 mM CuSO_4 , 0.5 M H_2SO_4 , and 1.41 mM KCl. The Cu film was electrodeposited onto a stationary Ru coupon with solution agitation provided by a magnetic stir bar rotating at 150 RPM.

7. Conclusions:

- “compressive” should be replaced with “tensile”.
- “-6.9%” should be replaced with “5.9%”.
- “-8.3%” should be replaced with “7.4%”.
- “Cu $[1\bar{1}0]$ || Ru $[10\bar{1}0]$ ” should be replaced with “Cu $[1\bar{1}0]$ || Ru $[11\bar{2}0]$ ”.