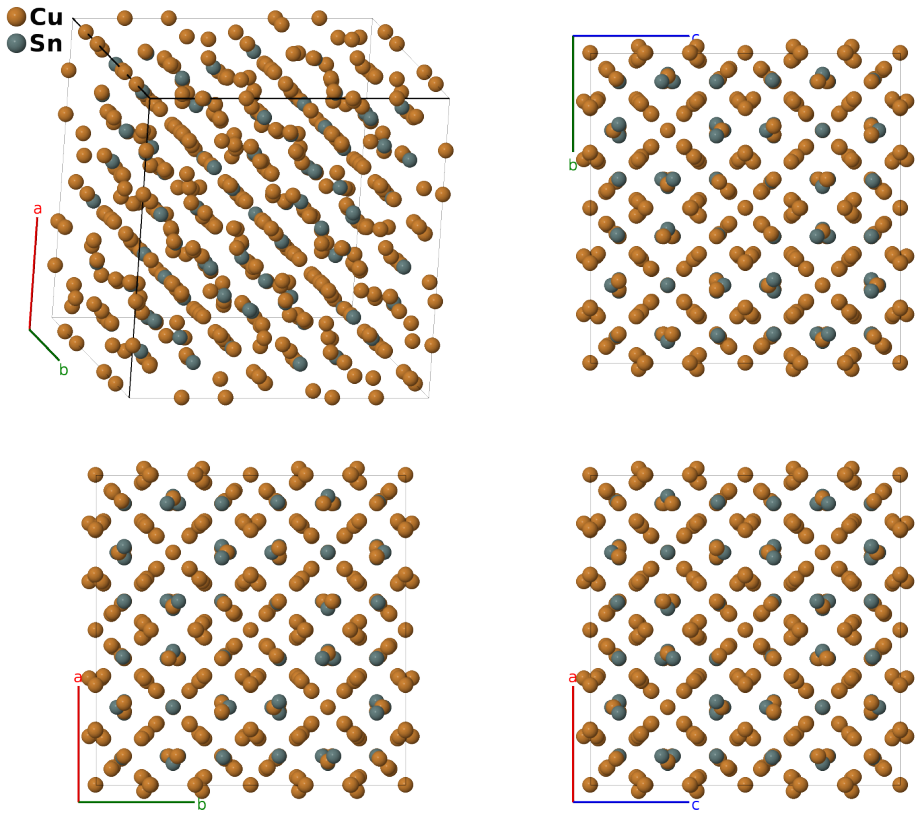
δ-$Cu_{41}Sn_{11}$ Structure: A41B11_cF416_216_7e2fg3h_egh-001

Cite this page as: H. Eckert, S. Divilov, A. Zettel, M. J. Mehl, D. Hicks, and S. Curtarolo, *The AFLOW Library of Crystallographic Prototypes: Part 4*. In preparation.

https://aflow.org/p/1MZW

https://aflow.org/p/A41B11_cF416_216_7e2fg3h_egh-001

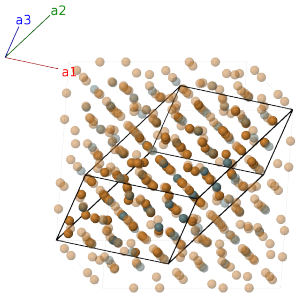


Prototype	$Cu_{41}Sn_{11}$
AFLOW prototype label	A41B11_cF416_216_7e2fg3h_egh-001
ICSD	none
Pearson symbol	cF416
Space group number	216
Space group symbol	$F\bar{4}3m$
AFLOW prototype command	`aflow --proto=A41B11_cF416_216_7e2fg3h_egh-001 --params=`$a, x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, z_{13}, x_{14}, z_{14}, x_{15}, z_{15}, x_{16}, z_{16}$

- This is designated as the δ phase in the Cu-Sn system. (Massalski, 1990)
- We have shifted the origin by $a(\hat{x}+\hat{y}+\hat{z})/4$ from that used by (Misra, 2021).

Face-centered Cubic primitive vectors

$$\mathbf{a_1} = \frac{1}{2}a\,\hat{\mathbf{y}} + \frac{1}{2}a\,\hat{\mathbf{z}}$$
$$\mathbf{a_2} = \frac{1}{2}a\,\hat{\mathbf{x}} + \frac{1}{2}a\,\hat{\mathbf{z}}$$
$$\mathbf{a_3} = \frac{1}{2}a\,\hat{\mathbf{x}} + \frac{1}{2}a\,\hat{\mathbf{y}}$$



Basis vectors

		Lattice coordinates		Cartesian coordinates	Wyckoff position	Atom type
$\mathbf{B_1}$	=	$x_1\,\mathbf{a}_1 + x_1\,\mathbf{a}_2 + x_1\,\mathbf{a}_3$	=	$ax_1\,\hat{\mathbf{x}} + ax_1\,\hat{\mathbf{y}} + ax_1\,\hat{\mathbf{z}}$	(16e)	Cu I
$\mathbf{B_2}$	=	$x_1\,\mathbf{a}_1 + x_1\,\mathbf{a}_2 - 3x_1\,\mathbf{a}_3$	=	$-ax_1\,\hat{\mathbf{x}} - ax_1\,\hat{\mathbf{y}} + ax_1\,\hat{\mathbf{z}}$	(16e)	Cu I
$\mathbf{B_3}$	=	$x_1\,\mathbf{a}_1 - 3x_1\,\mathbf{a}_2 + x_1\,\mathbf{a}_3$	=	$-ax_1\,\hat{\mathbf{x}} + ax_1\,\hat{\mathbf{y}} - ax_1\,\hat{\mathbf{z}}$	(16e)	Cu I
$\mathbf{B_4}$	=	$-3x_1\,\mathbf{a}_1 + x_1\,\mathbf{a}_2 + x_1\,\mathbf{a}_3$	=	$ax_1\,\hat{\mathbf{x}} - ax_1\,\hat{\mathbf{y}} - ax_1\,\hat{\mathbf{z}}$	(16e)	Cu I
$\mathbf{B_5}$	=	$x_2\,\mathbf{a}_1 + x_2\,\mathbf{a}_2 + x_2\,\mathbf{a}_3$	=	$ax_2\,\hat{\mathbf{x}} + ax_2\,\hat{\mathbf{y}} + ax_2\,\hat{\mathbf{z}}$	(16e)	Cu II
$\mathbf{B_6}$	=	$x_2\,\mathbf{a}_1 + x_2\,\mathbf{a}_2 - 3x_2\,\mathbf{a}_3$	=	$-ax_2\,\hat{\mathbf{x}} - ax_2\,\hat{\mathbf{y}} + ax_2\,\hat{\mathbf{z}}$	(16e)	Cu II
$\mathbf{B_7}$	=	$x_2\,\mathbf{a}_1 - 3x_2\,\mathbf{a}_2 + x_2\,\mathbf{a}_3$	=	$-ax_2\,\hat{\mathbf{x}} + ax_2\,\hat{\mathbf{y}} - ax_2\,\hat{\mathbf{z}}$	(16e)	Cu II
$\mathbf{B_8}$	=	$-3x_2\,\mathbf{a}_1 + x_2\,\mathbf{a}_2 + x_2\,\mathbf{a}_3$	=	$ax_2\,\hat{\mathbf{x}} - ax_2\,\hat{\mathbf{y}} - ax_2\,\hat{\mathbf{z}}$	(16e)	Cu II
$\mathbf{B_9}$	=	$x_3\,\mathbf{a}_1 + x_3\,\mathbf{a}_2 + x_3\,\mathbf{a}_3$	=	$ax_3\,\hat{\mathbf{x}} + ax_3\,\hat{\mathbf{y}} + ax_3\,\hat{\mathbf{z}}$	(16e)	Cu III
$\mathbf{B_{10}}$	=	$x_3\,\mathbf{a}_1 + x_3\,\mathbf{a}_2 - 3x_3\,\mathbf{a}_3$	=	$-ax_3\,\hat{\mathbf{x}} - ax_3\,\hat{\mathbf{y}} + ax_3\,\hat{\mathbf{z}}$	(16e)	Cu III
$\mathbf{B_{11}}$	=	$x_3\,\mathbf{a}_1 - 3x_3\,\mathbf{a}_2 + x_3\,\mathbf{a}_3$	=	$-ax_3\,\hat{\mathbf{x}} + ax_3\,\hat{\mathbf{y}} - ax_3\,\hat{\mathbf{z}}$	(16e)	Cu III
$\mathbf{B_{12}}$	=	$-3x_3\,\mathbf{a}_1 + x_3\,\mathbf{a}_2 + x_3\,\mathbf{a}_3$	=	$ax_3\,\hat{\mathbf{x}} - ax_3\,\hat{\mathbf{y}} - ax_3\,\hat{\mathbf{z}}$	(16e)	Cu III
$\mathbf{B_{13}}$	=	$x_4\,\mathbf{a}_1 + x_4\,\mathbf{a}_2 + x_4\,\mathbf{a}_3$	=	$ax_4\,\hat{\mathbf{x}} + ax_4\,\hat{\mathbf{y}} + ax_4\,\hat{\mathbf{z}}$	(16e)	Cu IV
$\mathbf{B_{14}}$	=	$x_4\,\mathbf{a}_1 + x_4\,\mathbf{a}_2 - 3x_4\,\mathbf{a}_3$	=	$-ax_4\,\hat{\mathbf{x}} - ax_4\,\hat{\mathbf{y}} + ax_4\,\hat{\mathbf{z}}$	(16e)	Cu IV
$\mathbf{B_{15}}$	=	$x_4\,\mathbf{a}_1 - 3x_4\,\mathbf{a}_2 + x_4\,\mathbf{a}_3$	=	$-ax_4\,\hat{\mathbf{x}} + ax_4\,\hat{\mathbf{y}} - ax_4\,\hat{\mathbf{z}}$	(16e)	Cu IV
$\mathbf{B_{16}}$	=	$-3x_4\,\mathbf{a}_1 + x_4\,\mathbf{a}_2 + x_4\,\mathbf{a}_3$	=	$ax_4\,\hat{\mathbf{x}} - ax_4\,\hat{\mathbf{y}} - ax_4\,\hat{\mathbf{z}}$	(16e)	Cu IV
$\mathbf{B_{17}}$	=	$x_5\,\mathbf{a}_1 + x_5\,\mathbf{a}_2 + x_5\,\mathbf{a}_3$	=	$ax_5\,\hat{\mathbf{x}} + ax_5\,\hat{\mathbf{y}} + ax_5\,\hat{\mathbf{z}}$	(16e)	Cu V
$\mathbf{B_{18}}$	=	$x_5\,\mathbf{a}_1 + x_5\,\mathbf{a}_2 - 3x_5\,\mathbf{a}_3$	=	$-ax_5\,\hat{\mathbf{x}} - ax_5\,\hat{\mathbf{y}} + ax_5\,\hat{\mathbf{z}}$	(16e)	Cu V
$\mathbf{B_{19}}$	=	$x_5\,\mathbf{a}_1 - 3x_5\,\mathbf{a}_2 + x_5\,\mathbf{a}_3$	=	$-ax_5\,\hat{\mathbf{x}} + ax_5\,\hat{\mathbf{y}} - ax_5\,\hat{\mathbf{z}}$	(16e)	Cu V
$\mathbf{B_{20}}$	=	$-3x_5\,\mathbf{a}_1 + x_5\,\mathbf{a}_2 + x_5\,\mathbf{a}_3$	=	$ax_5\,\hat{\mathbf{x}} - ax_5\,\hat{\mathbf{y}} - ax_5\,\hat{\mathbf{z}}$	(16e)	Cu V
$\mathbf{B_{21}}$	=	$x_6\,\mathbf{a}_1 + x_6\,\mathbf{a}_2 + x_6\,\mathbf{a}_3$	=	$ax_6\,\hat{\mathbf{x}} + ax_6\,\hat{\mathbf{y}} + ax_6\,\hat{\mathbf{z}}$	(16e)	Cu VI
$\mathbf{B_{22}}$	=	$x_6\,\mathbf{a}_1 + x_6\,\mathbf{a}_2 - 3x_6\,\mathbf{a}_3$	=	$-ax_6\,\hat{\mathbf{x}} - ax_6\,\hat{\mathbf{y}} + ax_6\,\hat{\mathbf{z}}$	(16e)	Cu VI
$\mathbf{B_{23}}$	=	$x_6\,\mathbf{a}_1 - 3x_6\,\mathbf{a}_2 + x_6\,\mathbf{a}_3$	=	$-ax_6\,\hat{\mathbf{x}} + ax_6\,\hat{\mathbf{y}} - ax_6\,\hat{\mathbf{z}}$	(16e)	Cu VI
$\mathbf{B_{24}}$	=	$-3x_6\,\mathbf{a}_1 + x_6\,\mathbf{a}_2 + x_6\,\mathbf{a}_3$	=	$ax_6\,\hat{\mathbf{x}} - ax_6\,\hat{\mathbf{y}} - ax_6\,\hat{\mathbf{z}}$	(16e)	Cu VI
$\mathbf{B_{25}}$	=	$x_7\,\mathbf{a}_1 + x_7\,\mathbf{a}_2 + x_7\,\mathbf{a}_3$	=	$ax_7\,\hat{\mathbf{x}} + ax_7\,\hat{\mathbf{y}} + ax_7\,\hat{\mathbf{z}}$	(16e)	Cu VII
$\mathbf{B_{26}}$	=	$x_7\,\mathbf{a}_1 + x_7\,\mathbf{a}_2 - 3x_7\,\mathbf{a}_3$	=	$-ax_7\,\hat{\mathbf{x}} - ax_7\,\hat{\mathbf{y}} + ax_7\,\hat{\mathbf{z}}$	(16e)	Cu VII
$\mathbf{B_{27}}$	=	$x_7\,\mathbf{a}_1 - 3x_7\,\mathbf{a}_2 + x_7\,\mathbf{a}_3$	=	$-ax_7\,\hat{\mathbf{x}} + ax_7\,\hat{\mathbf{y}} - ax_7\,\hat{\mathbf{z}}$	(16e)	Cu VII
$\mathbf{B_{28}}$	=	$-3x_7\,\mathbf{a}_1 + x_7\,\mathbf{a}_2 + x_7\,\mathbf{a}_3$	=	$ax_7\,\hat{\mathbf{x}} - ax_7\,\hat{\mathbf{y}} - ax_7\,\hat{\mathbf{z}}$	(16e)	Cu VII

$\mathbf{B_{29}}$	=	$x_8\,\mathbf{a}_1 + x_8\,\mathbf{a}_2 + x_8\,\mathbf{a}_3$	=	$ax_8\,\hat{\mathbf{x}} + ax_8\,\hat{\mathbf{y}} + ax_8\,\hat{\mathbf{z}}$	(16e)	Sn I
$\mathbf{B_{30}}$	=	$x_8\,\mathbf{a}_1 + x_8\,\mathbf{a}_2 - 3x_8\,\mathbf{a}_3$	=	$-ax_8\,\hat{\mathbf{x}} - ax_8\,\hat{\mathbf{y}} + ax_8\,\hat{\mathbf{z}}$	(16e)	Sn I
$\mathbf{B_{31}}$	=	$x_8\,\mathbf{a}_1 - 3x_8\,\mathbf{a}_2 + x_8\,\mathbf{a}_3$	=	$-ax_8\,\hat{\mathbf{x}} + ax_8\,\hat{\mathbf{y}} - ax_8\,\hat{\mathbf{z}}$	(16e)	Sn I
$\mathbf{B_{32}}$	=	$-3x_8\,\mathbf{a}_1 + x_8\,\mathbf{a}_2 + x_8\,\mathbf{a}_3$	=	$ax_8\,\hat{\mathbf{x}} - ax_8\,\hat{\mathbf{y}} - ax_8\,\hat{\mathbf{z}}$	(16e)	Sn I
$\mathbf{B_{33}}$	=	$-x_9\,\mathbf{a}_1 + x_9\,\mathbf{a}_2 + x_9\,\mathbf{a}_3$	=	$ax_9\,\hat{\mathbf{x}}$	(24f)	Cu VIII
$\mathbf{B_{34}}$	=	$x_9\,\mathbf{a}_1 - x_9\,\mathbf{a}_2 - x_9\,\mathbf{a}_3$	=	$-ax_9\,\hat{\mathbf{x}}$	(24f)	Cu VIII
$\mathbf{B_{35}}$	=	$x_9\,\mathbf{a}_1 - x_9\,\mathbf{a}_2 + x_9\,\mathbf{a}_3$	=	$ax_9\,\hat{\mathbf{y}}$	(24f)	Cu VIII
$\mathbf{B_{36}}$	=	$-x_9\,\mathbf{a}_1 + x_9\,\mathbf{a}_2 - x_9\,\mathbf{a}_3$	=	$-ax_9\,\hat{\mathbf{y}}$	(24f)	Cu VIII
$\mathbf{B_{37}}$	=	$x_9\,\mathbf{a}_1 + x_9\,\mathbf{a}_2 - x_9\,\mathbf{a}_3$	=	$ax_9\,\hat{\mathbf{z}}$	(24f)	Cu VIII
$\mathbf{B_{38}}$	=	$-x_9\,\mathbf{a}_1 - x_9\,\mathbf{a}_2 + x_9\,\mathbf{a}_3$	=	$-ax_9\,\hat{\mathbf{z}}$	(24f)	Cu VIII
$\mathbf{B_{39}}$	=	$-x_{10}\,\mathbf{a}_1 + x_{10}\,\mathbf{a}_2 + x_{10}\,\mathbf{a}_3$	=	$ax_{10}\,\hat{\mathbf{x}}$	(24f)	Cu IX
$\mathbf{B_{40}}$	=	$x_{10}\,\mathbf{a}_1 - x_{10}\,\mathbf{a}_2 - x_{10}\,\mathbf{a}_3$	=	$-ax_{10}\,\hat{\mathbf{x}}$	(24f)	Cu IX
$\mathbf{B_{41}}$	=	$x_{10}\,\mathbf{a}_1 - x_{10}\,\mathbf{a}_2 + x_{10}\,\mathbf{a}_3$	=	$ax_{10}\,\hat{\mathbf{y}}$	(24f)	Cu IX
$\mathbf{B_{42}}$	=	$-x_{10}\,\mathbf{a}_1 + x_{10}\,\mathbf{a}_2 - x_{10}\,\mathbf{a}_3$	=	$-ax_{10}\,\hat{\mathbf{y}}$	(24f)	Cu IX
$\mathbf{B_{43}}$	=	$x_{10}\,\mathbf{a}_1 + x_{10}\,\mathbf{a}_2 - x_{10}\,\mathbf{a}_3$	=	$ax_{10}\,\hat{\mathbf{z}}$	(24f)	Cu IX
$\mathbf{B_{44}}$	=	$-x_{10}\,\mathbf{a}_1 - x_{10}\,\mathbf{a}_2 + x_{10}\,\mathbf{a}_3$	=	$-ax_{10}\,\hat{\mathbf{z}}$	(24f)	Cu IX
$\mathbf{B_{45}}$	=	$-\left(x_{11} - \frac{1}{2}\right)\,\mathbf{a}_1 + x_{11}\,\mathbf{a}_2 + x_{11}\,\mathbf{a}_3$	=	$ax_{11}\,\hat{\mathbf{x}} + \frac{1}{4}a\,\hat{\mathbf{y}} + \frac{1}{4}a\,\hat{\mathbf{z}}$	(24g)	Cu X
$\mathbf{B_{46}}$	=	$x_{11}\,\mathbf{a}_1 - \left(x_{11} - \frac{1}{2}\right)\,\mathbf{a}_2 - \left(x_{11} - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$-a\left(x_{11} - \frac{1}{2}\right)\,\hat{\mathbf{x}} + \frac{1}{4}a\,\hat{\mathbf{y}} + \frac{1}{4}a\,\hat{\mathbf{z}}$	(24g)	Cu X
$\mathbf{B_{47}}$	=	$x_{11}\,\mathbf{a}_1 - \left(x_{11} - \frac{1}{2}\right)\,\mathbf{a}_2 + x_{11}\,\mathbf{a}_3$	=	$\frac{1}{4}a\,\hat{\mathbf{x}} + ax_{11}\,\hat{\mathbf{y}} + \frac{1}{4}a\,\hat{\mathbf{z}}$	(24g)	Cu X
$\mathbf{B_{48}}$	=	$-\left(x_{11} - \frac{1}{2}\right)\,\mathbf{a}_1 + x_{11}\,\mathbf{a}_2 - \left(x_{11} - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{4}a\,\hat{\mathbf{x}} - a\left(x_{11} - \frac{1}{2}\right)\,\hat{\mathbf{y}} + \frac{1}{4}a\,\hat{\mathbf{z}}$	(24g)	Cu X
$\mathbf{B_{49}}$	=	$x_{11}\,\mathbf{a}_1 + x_{11}\,\mathbf{a}_2 - \left(x_{11} - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{4}a\,\hat{\mathbf{x}} + \frac{1}{4}a\,\hat{\mathbf{y}} + ax_{11}\,\hat{\mathbf{z}}$	(24g)	Cu X
$\mathbf{B_{50}}$	=	$-\left(x_{11} - \frac{1}{2}\right)\,\mathbf{a}_1 - \left(x_{11} - \frac{1}{2}\right)\,\mathbf{a}_2 + x_{11}\,\mathbf{a}_3$	=	$\frac{1}{4}a\,\hat{\mathbf{x}} + \frac{1}{4}a\,\hat{\mathbf{y}} - a\left(x_{11} - \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(24g)	Cu X
$\mathbf{B_{51}}$	=	$-\left(x_{12} - \frac{1}{2}\right)\,\mathbf{a}_1 + x_{12}\,\mathbf{a}_2 + x_{12}\,\mathbf{a}_3$	=	$ax_{12}\,\hat{\mathbf{x}} + \frac{1}{4}a\,\hat{\mathbf{y}} + \frac{1}{4}a\,\hat{\mathbf{z}}$	(24g)	Sn II
$\mathbf{B_{52}}$	=	$x_{12}\,\mathbf{a}_1 - \left(x_{12} - \frac{1}{2}\right)\,\mathbf{a}_2 - \left(x_{12} - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$-a\left(x_{12} - \frac{1}{2}\right)\,\hat{\mathbf{x}} + \frac{1}{4}a\,\hat{\mathbf{y}} + \frac{1}{4}a\,\hat{\mathbf{z}}$	(24g)	Sn II
$\mathbf{B_{53}}$	=	$x_{12}\,\mathbf{a}_1 - \left(x_{12} - \frac{1}{2}\right)\,\mathbf{a}_2 + x_{12}\,\mathbf{a}_3$	=	$\frac{1}{4}a\,\hat{\mathbf{x}} + ax_{12}\,\hat{\mathbf{y}} + \frac{1}{4}a\,\hat{\mathbf{z}}$	(24g)	Sn II
$\mathbf{B_{54}}$	=	$-\left(x_{12} - \frac{1}{2}\right)\,\mathbf{a}_1 + x_{12}\,\mathbf{a}_2 - \left(x_{12} - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{4}a\,\hat{\mathbf{x}} - a\left(x_{12} - \frac{1}{2}\right)\,\hat{\mathbf{y}} + \frac{1}{4}a\,\hat{\mathbf{z}}$	(24g)	Sn II
$\mathbf{B_{55}}$	=	$x_{12}\,\mathbf{a}_1 + x_{12}\,\mathbf{a}_2 - \left(x_{12} - \frac{1}{2}\right)\,\mathbf{a}_3$	=	$\frac{1}{4}a\,\hat{\mathbf{x}} + \frac{1}{4}a\,\hat{\mathbf{y}} + ax_{12}\,\hat{\mathbf{z}}$	(24g)	Sn II
$\mathbf{B_{56}}$	=	$-\left(x_{12} - \frac{1}{2}\right)\,\mathbf{a}_1 - \left(x_{12} - \frac{1}{2}\right)\,\mathbf{a}_2 + x_{12}\,\mathbf{a}_3$	=	$\frac{1}{4}a\,\hat{\mathbf{x}} + \frac{1}{4}a\,\hat{\mathbf{y}} - a\left(x_{12} - \frac{1}{2}\right)\,\hat{\mathbf{z}}$	(24g)	Sn II
$\mathbf{B_{57}}$	=	$z_{13}\,\mathbf{a}_1 + z_{13}\,\mathbf{a}_2 + (2x_{13} - z_{13})\,\mathbf{a}_3$	=	$ax_{13}\,\hat{\mathbf{x}} + ax_{13}\,\hat{\mathbf{y}} + az_{13}\,\hat{\mathbf{z}}$	(48h)	Cu XI
$\mathbf{B_{58}}$	=	$z_{13}\,\mathbf{a}_1 + z_{13}\,\mathbf{a}_2 - (2x_{13} + z_{13})\,\mathbf{a}_3$	=	$-ax_{13}\,\hat{\mathbf{x}} - ax_{13}\,\hat{\mathbf{y}} + az_{13}\,\hat{\mathbf{z}}$	(48h)	Cu XI
$\mathbf{B_{59}}$	=	$(2x_{13} - z_{13})\,\mathbf{a}_1 - (2x_{13} + z_{13})\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3$	=	$-ax_{13}\,\hat{\mathbf{x}} + ax_{13}\,\hat{\mathbf{y}} - az_{13}\,\hat{\mathbf{z}}$	(48h)	Cu XI
$\mathbf{B_{60}}$	=	$-(2x_{13} + z_{13})\,\mathbf{a}_1 + (2x_{13} - z_{13})\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3$	=	$ax_{13}\,\hat{\mathbf{x}} - ax_{13}\,\hat{\mathbf{y}} - az_{13}\,\hat{\mathbf{z}}$	(48h)	Cu XI
$\mathbf{B_{61}}$	=	$(2x_{13} - z_{13})\,\mathbf{a}_1 + z_{13}\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3$	=	$az_{13}\,\hat{\mathbf{x}} + ax_{13}\,\hat{\mathbf{y}} + ax_{13}\,\hat{\mathbf{z}}$	(48h)	Cu XI
$\mathbf{B_{62}}$	=	$-(2x_{13} + z_{13})\,\mathbf{a}_1 + z_{13}\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3$	=	$az_{13}\,\hat{\mathbf{x}} - ax_{13}\,\hat{\mathbf{y}} - ax_{13}\,\hat{\mathbf{z}}$	(48h)	Cu XI
$\mathbf{B_{63}}$	=	$z_{13}\,\mathbf{a}_1 + (2x_{13} - z_{13})\,\mathbf{a}_2 - (2x_{13} + z_{13})\,\mathbf{a}_3$	=	$-az_{13}\,\hat{\mathbf{x}} - ax_{13}\,\hat{\mathbf{y}} + ax_{13}\,\hat{\mathbf{z}}$	(48h)	Cu XI

$$\mathbf{B_{64}} = z_{13}\,\mathbf{a}_1 - (2x_{13} + z_{13})\,\mathbf{a}_2 + (2x_{13} - z_{13})\,\mathbf{a}_3 = -az_{13}\,\hat{\mathbf{x}} + ax_{13}\,\hat{\mathbf{y}} - ax_{13}\,\hat{\mathbf{z}}$$ (48h) Cu XI

$$\mathbf{B_{65}} = z_{13}\,\mathbf{a}_1 + (2x_{13} - z_{13})\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3 = ax_{13}\,\hat{\mathbf{x}} + az_{13}\,\hat{\mathbf{y}} + ax_{13}\,\hat{\mathbf{z}}$$ (48h) Cu XI

$$\mathbf{B_{66}} = z_{13}\,\mathbf{a}_1 - (2x_{13} + z_{13})\,\mathbf{a}_2 + z_{13}\,\mathbf{a}_3 = -ax_{13}\,\hat{\mathbf{x}} + az_{13}\,\hat{\mathbf{y}} - ax_{13}\,\hat{\mathbf{z}}$$ (48h) Cu XI

$$\mathbf{B_{67}} = -(2x_{13} + z_{13})\,\mathbf{a}_1 + z_{13}\,\mathbf{a}_2 + (2x_{13} - z_{13})\,\mathbf{a}_3 = ax_{13}\,\hat{\mathbf{x}} - az_{13}\,\hat{\mathbf{y}} - ax_{13}\,\hat{\mathbf{z}}$$ (48h) Cu XI

$$\mathbf{B_{68}} = (2x_{13} - z_{13})\,\mathbf{a}_1 + z_{13}\,\mathbf{a}_2 - (2x_{13} + z_{13})\,\mathbf{a}_3 = -ax_{13}\,\hat{\mathbf{x}} - az_{13}\,\hat{\mathbf{y}} + ax_{13}\,\hat{\mathbf{z}}$$ (48h) Cu XI

$$\mathbf{B_{69}} = z_{14}\,\mathbf{a}_1 + z_{14}\,\mathbf{a}_2 + (2x_{14} - z_{14})\,\mathbf{a}_3 = ax_{14}\,\hat{\mathbf{x}} + ax_{14}\,\hat{\mathbf{y}} + az_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{70}} = z_{14}\,\mathbf{a}_1 + z_{14}\,\mathbf{a}_2 - (2x_{14} + z_{14})\,\mathbf{a}_3 = -ax_{14}\,\hat{\mathbf{x}} - ax_{14}\,\hat{\mathbf{y}} + az_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{71}} = (2x_{14} - z_{14})\,\mathbf{a}_1 - (2x_{14} + z_{14})\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3 = -ax_{14}\,\hat{\mathbf{x}} + ax_{14}\,\hat{\mathbf{y}} - az_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{72}} = -(2x_{14} + z_{14})\,\mathbf{a}_1 + (2x_{14} - z_{14})\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3 = ax_{14}\,\hat{\mathbf{x}} - ax_{14}\,\hat{\mathbf{y}} - az_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{73}} = (2x_{14} - z_{14})\,\mathbf{a}_1 + z_{14}\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3 = az_{14}\,\hat{\mathbf{x}} + ax_{14}\,\hat{\mathbf{y}} + ax_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{74}} = -(2x_{14} + z_{14})\,\mathbf{a}_1 + z_{14}\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3 = az_{14}\,\hat{\mathbf{x}} - ax_{14}\,\hat{\mathbf{y}} - ax_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{75}} = z_{14}\,\mathbf{a}_1 + (2x_{14} - z_{14})\,\mathbf{a}_2 - (2x_{14} + z_{14})\,\mathbf{a}_3 = -az_{14}\,\hat{\mathbf{x}} - ax_{14}\,\hat{\mathbf{y}} + ax_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{76}} = z_{14}\,\mathbf{a}_1 - (2x_{14} + z_{14})\,\mathbf{a}_2 + (2x_{14} - z_{14})\,\mathbf{a}_3 = -az_{14}\,\hat{\mathbf{x}} + ax_{14}\,\hat{\mathbf{y}} - ax_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{77}} = z_{14}\,\mathbf{a}_1 + (2x_{14} - z_{14})\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3 = ax_{14}\,\hat{\mathbf{x}} + az_{14}\,\hat{\mathbf{y}} + ax_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{78}} = z_{14}\,\mathbf{a}_1 - (2x_{14} + z_{14})\,\mathbf{a}_2 + z_{14}\,\mathbf{a}_3 = -ax_{14}\,\hat{\mathbf{x}} + az_{14}\,\hat{\mathbf{y}} - ax_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{79}} = -(2x_{14} + z_{14})\,\mathbf{a}_1 + z_{14}\,\mathbf{a}_2 + (2x_{14} - z_{14})\,\mathbf{a}_3 = ax_{14}\,\hat{\mathbf{x}} - az_{14}\,\hat{\mathbf{y}} - ax_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{80}} = (2x_{14} - z_{14})\,\mathbf{a}_1 + z_{14}\,\mathbf{a}_2 - (2x_{14} + z_{14})\,\mathbf{a}_3 = -ax_{14}\,\hat{\mathbf{x}} - az_{14}\,\hat{\mathbf{y}} + ax_{14}\,\hat{\mathbf{z}}$$ (48h) Cu XII

$$\mathbf{B_{81}} = z_{15}\,\mathbf{a}_1 + z_{15}\,\mathbf{a}_2 + (2x_{15} - z_{15})\,\mathbf{a}_3 = ax_{15}\,\hat{\mathbf{x}} + ax_{15}\,\hat{\mathbf{y}} + az_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{82}} = z_{15}\,\mathbf{a}_1 + z_{15}\,\mathbf{a}_2 - (2x_{15} + z_{15})\,\mathbf{a}_3 = -ax_{15}\,\hat{\mathbf{x}} - ax_{15}\,\hat{\mathbf{y}} + az_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{83}} = (2x_{15} - z_{15})\,\mathbf{a}_1 - (2x_{15} + z_{15})\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3 = -ax_{15}\,\hat{\mathbf{x}} + ax_{15}\,\hat{\mathbf{y}} - az_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{84}} = -(2x_{15} + z_{15})\,\mathbf{a}_1 + (2x_{15} - z_{15})\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3 = ax_{15}\,\hat{\mathbf{x}} - ax_{15}\,\hat{\mathbf{y}} - az_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{85}} = (2x_{15} - z_{15})\,\mathbf{a}_1 + z_{15}\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3 = az_{15}\,\hat{\mathbf{x}} + ax_{15}\,\hat{\mathbf{y}} + ax_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{86}} = -(2x_{15} + z_{15})\,\mathbf{a}_1 + z_{15}\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3 = az_{15}\,\hat{\mathbf{x}} - ax_{15}\,\hat{\mathbf{y}} - ax_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{87}} = z_{15}\,\mathbf{a}_1 + (2x_{15} - z_{15})\,\mathbf{a}_2 - (2x_{15} + z_{15})\,\mathbf{a}_3 = -az_{15}\,\hat{\mathbf{x}} - ax_{15}\,\hat{\mathbf{y}} + ax_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{88}} = z_{15}\,\mathbf{a}_1 - (2x_{15} + z_{15})\,\mathbf{a}_2 + (2x_{15} - z_{15})\,\mathbf{a}_3 = -az_{15}\,\hat{\mathbf{x}} + ax_{15}\,\hat{\mathbf{y}} - ax_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{89}} = z_{15}\,\mathbf{a}_1 + (2x_{15} - z_{15})\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3 = ax_{15}\,\hat{\mathbf{x}} + az_{15}\,\hat{\mathbf{y}} + ax_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{90}} = z_{15}\,\mathbf{a}_1 - (2x_{15} + z_{15})\,\mathbf{a}_2 + z_{15}\,\mathbf{a}_3 = -ax_{15}\,\hat{\mathbf{x}} + az_{15}\,\hat{\mathbf{y}} - ax_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{91}} = -(2x_{15} + z_{15})\,\mathbf{a}_1 + z_{15}\,\mathbf{a}_2 + (2x_{15} - z_{15})\,\mathbf{a}_3 = ax_{15}\,\hat{\mathbf{x}} - az_{15}\,\hat{\mathbf{y}} - ax_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{92}} = (2x_{15} - z_{15})\,\mathbf{a}_1 + z_{15}\,\mathbf{a}_2 - (2x_{15} + z_{15})\,\mathbf{a}_3 = -ax_{15}\,\hat{\mathbf{x}} - az_{15}\,\hat{\mathbf{y}} + ax_{15}\,\hat{\mathbf{z}}$$ (48h) Cu XIII

$$\mathbf{B_{93}} = z_{16}\,\mathbf{a}_1 + z_{16}\,\mathbf{a}_2 + (2x_{16} - z_{16})\,\mathbf{a}_3 = ax_{16}\,\hat{\mathbf{x}} + ax_{16}\,\hat{\mathbf{y}} + az_{16}\,\hat{\mathbf{z}}$$ (48h) Sn III

$\mathbf{B_{94}}$	=	$z_{16}\,\mathbf{a}_1 + z_{16}\,\mathbf{a}_2 - (2x_{16} + z_{16})\,\mathbf{a}_3$	=	$-ax_{16}\,\hat{\mathbf{x}} - ax_{16}\,\hat{\mathbf{y}} + az_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{95}}$	=	$(2x_{16} - z_{16})\,\mathbf{a}_1 - (2x_{16} + z_{16})\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3$	=	$-ax_{16}\,\hat{\mathbf{x}} + ax_{16}\,\hat{\mathbf{y}} - az_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{96}}$	=	$-(2x_{16} + z_{16})\,\mathbf{a}_1 + (2x_{16} - z_{16})\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3$	=	$ax_{16}\,\hat{\mathbf{x}} - ax_{16}\,\hat{\mathbf{y}} - az_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{97}}$	=	$(2x_{16} - z_{16})\,\mathbf{a}_1 + z_{16}\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3$	=	$az_{16}\,\hat{\mathbf{x}} + ax_{16}\,\hat{\mathbf{y}} + ax_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{98}}$	=	$-(2x_{16} + z_{16})\,\mathbf{a}_1 + z_{16}\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3$	=	$az_{16}\,\hat{\mathbf{x}} - ax_{16}\,\hat{\mathbf{y}} - ax_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{99}}$	=	$z_{16}\,\mathbf{a}_1 + (2x_{16} - z_{16})\,\mathbf{a}_2 - (2x_{16} + z_{16})\,\mathbf{a}_3$	=	$-az_{16}\,\hat{\mathbf{x}} - ax_{16}\,\hat{\mathbf{y}} + ax_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{100}}$	=	$z_{16}\,\mathbf{a}_1 - (2x_{16} + z_{16})\,\mathbf{a}_2 + (2x_{16} - z_{16})\,\mathbf{a}_3$	=	$-az_{16}\,\hat{\mathbf{x}} + ax_{16}\,\hat{\mathbf{y}} - ax_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{101}}$	=	$z_{16}\,\mathbf{a}_1 + (2x_{16} - z_{16})\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3$	=	$ax_{16}\,\hat{\mathbf{x}} + az_{16}\,\hat{\mathbf{y}} + ax_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{102}}$	=	$z_{16}\,\mathbf{a}_1 - (2x_{16} + z_{16})\,\mathbf{a}_2 + z_{16}\,\mathbf{a}_3$	=	$-ax_{16}\,\hat{\mathbf{x}} + az_{16}\,\hat{\mathbf{y}} - ax_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{103}}$	=	$-(2x_{16} + z_{16})\,\mathbf{a}_1 + z_{16}\,\mathbf{a}_2 + (2x_{16} - z_{16})\,\mathbf{a}_3$	=	$ax_{16}\,\hat{\mathbf{x}} - az_{16}\,\hat{\mathbf{y}} - ax_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III
$\mathbf{B_{104}}$	=	$(2x_{16} - z_{16})\,\mathbf{a}_1 + z_{16}\,\mathbf{a}_2 - (2x_{16} + z_{16})\,\mathbf{a}_3$	=	$-ax_{16}\,\hat{\mathbf{x}} - az_{16}\,\hat{\mathbf{y}} + ax_{16}\,\hat{\mathbf{z}}$	(48h)	Sn III

References

[1] S. Misra, D. Pahari, S. Giri, F. Wang, S. Puravankara, and P. P. Jana, *The γ-brass type Cu-rich complex intermetallic phase $Cu_{41}Sn_{11}$: Structure and electrochemical study*, Solid State Sci. **119**, 106682 (2021), doi:10.1016/j.solidstatesciences.2021.106682.

[2] T. B. Massalski, H. Okamoto, P. R. S., and L. Kacprzak, eds., *Binary Alloy Phase Diagrams* (ASM International, Materials Park, Ohio, USA, 1990), vol. 2, chap. Cu-Sn (Copper-Tin), pp. 1481–1483, 2^{nd} edn.

[3] U. Mizutani, *Hume-Rothery Rules for Structurally Complex Alloy Phases* (CRC Press, Boca Raton, London, New York, 2010).