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LETTER

Chessboard structures: Atom-scale imaging of homologs from the kobellite series

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ABSTRACT

High-angle annular dark-field scanning transmission electron microscopy is a powerful *Z*-contrast technique able to depict the structural motifs in Pb-(Bi-Sb)-sulfosalts. Using two homologs from the kobellite homologous series, a group of "chessboard derivative structures," represented by Bi-, and Sb-rich pairs of natural phases (the kobellite-tintinaite isotypic series and giessenite-izoklakeite homeotypic series), we visualize the slabs underpinning crystal structural modularity for the $N = 2$ homolog kobellite and the $N = 4$ homolog, in this case a Bi-rich izoklakeite [Sb/(Sb+Bi) = 0.35]. The homolog number, N, can be readily calculated as $N = n_1/6 - 1$ and $N = n_2/4$, where n_1 and n_2 are the numbers of atoms in the PbS- and SnS-motifs, respectively. Atom-scale imaging of thinned foils extracted in situ from samples for which compositional data are available also reveals syntactic unit-cell scale intergrowths on [001] zone axis with $a_{kobellite} \parallel b_{izoklakeite}$. These are as small as half-unit cells of $b_{izoklakeite}$ and one-unit cell $a_{kobellite}$. Replacement relationships are also observed as irregular slabs of kobellite "intruding" into izoklakeite. Both banded and irregular intergrowths account for the compositional fields measured at the micrometer scale.

Keywords: HAADF STEM, chessboard structures, izoklakeite, kobellite