

## Supplementary Information for:

### Quantifying the polar skyrmion motion barrier in an oxide heterostructure

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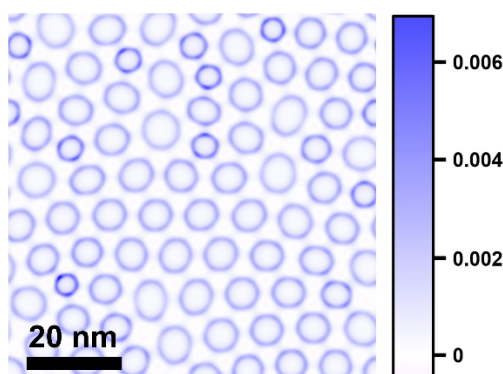


Fig. S1| The Pontryagin density of the initial state with a periodicity of 12 u.c.

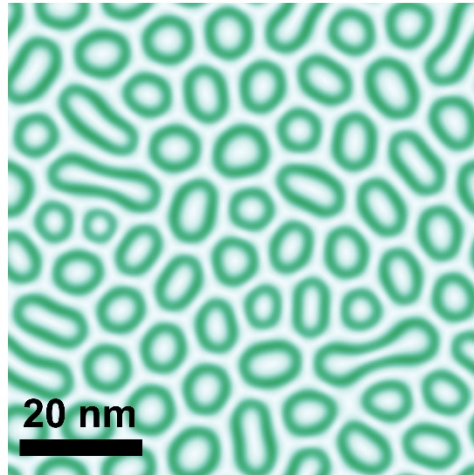


Fig. S2| The pattern of the in-plane polarization with periodicity of 6 u.c. at 300 K.

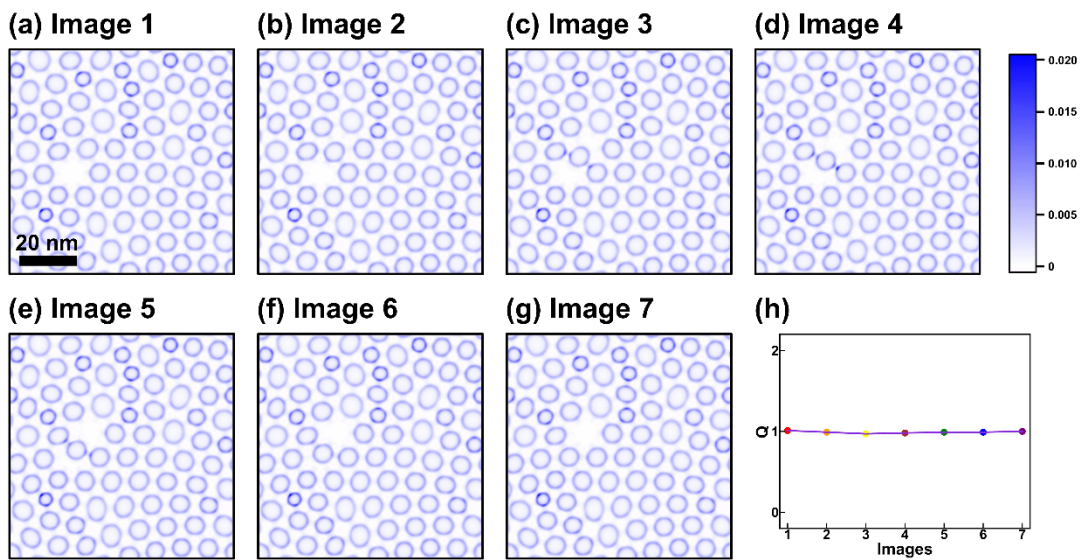


Fig. S3| The Pontryagin density during the migration corresponding to Fig. 3(a-g). (h) The topological charge  $Q$  over the migration process.

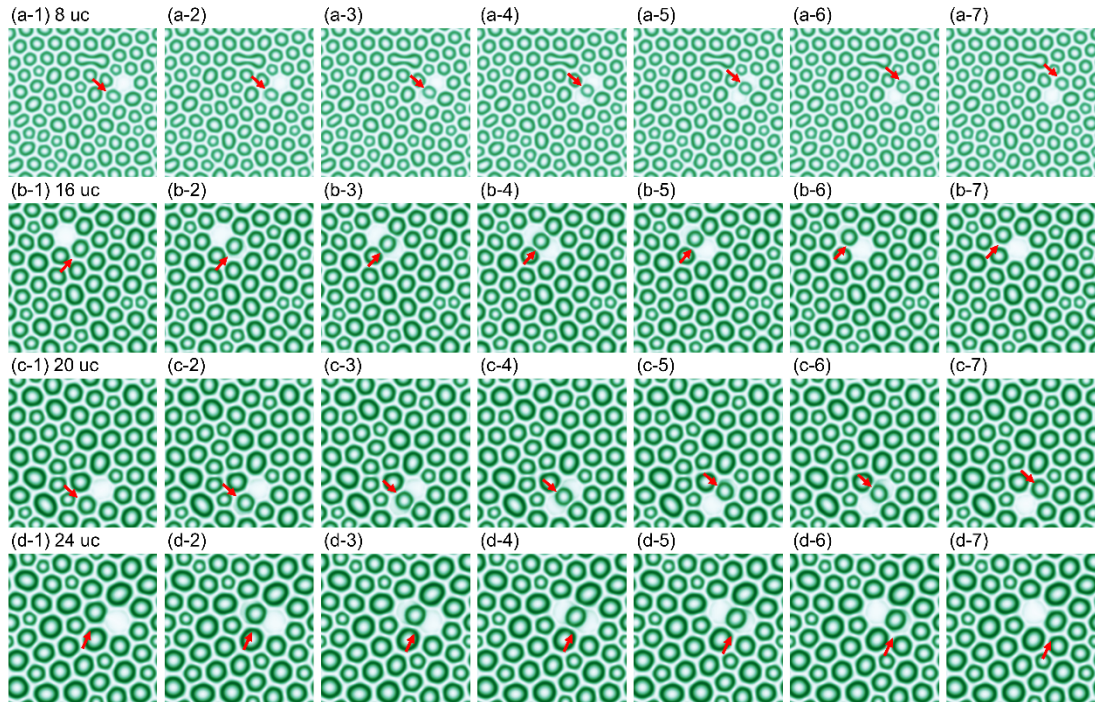


Fig. S4| The migration pathway of 8 u.c. (a-1 to a-7), 16 u.c. (b-1 to b-7), 20 u.c. (c-1 to c-7), 24 u.c. (d-1 to d-7), respectively.

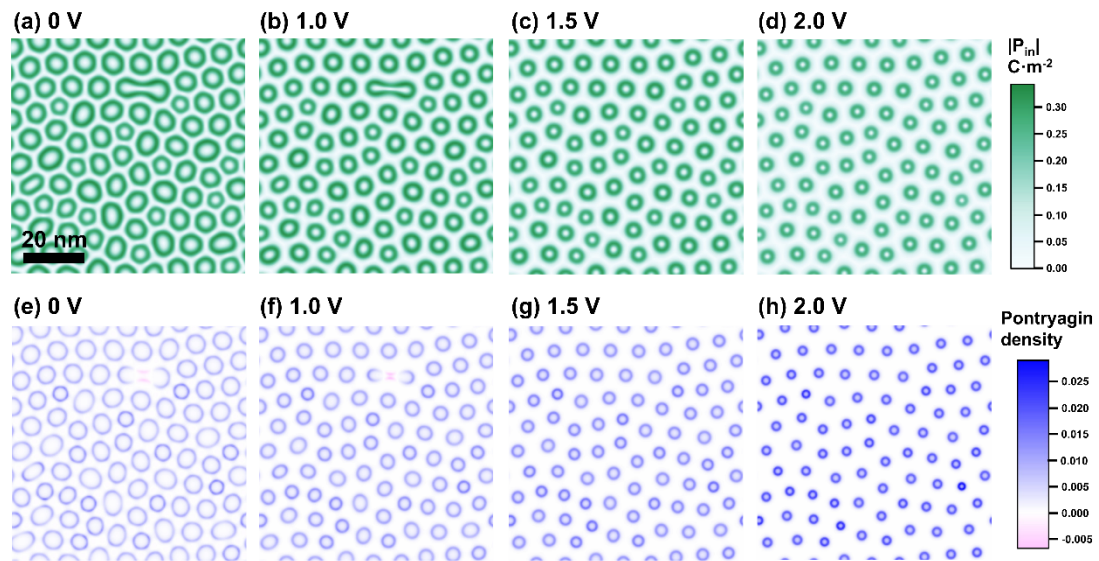


Fig. S5| The polar patterns (a-d) and corresponding Pontryagin density (e-h) of the top PTO layer for the superlattice with a periodicity of 8 u.c. under different applied voltages.

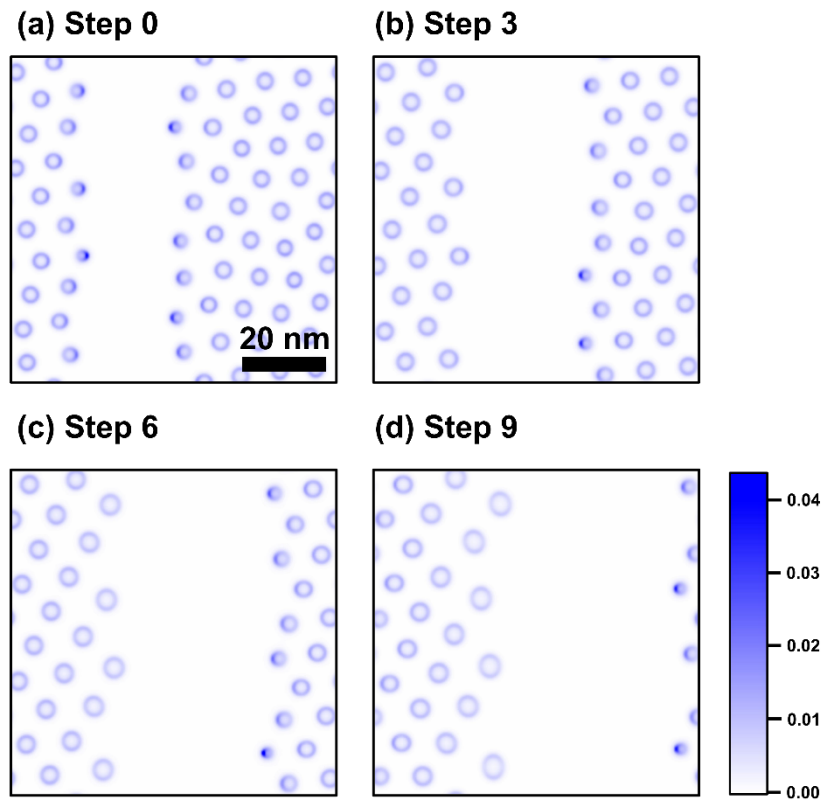


Fig. S6| The Pontryagin density of the system during the skyrmion motion process.