

Macroscopic low-friction via twinning assisted lattice reconstruction in magnesium

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KEYWORDS

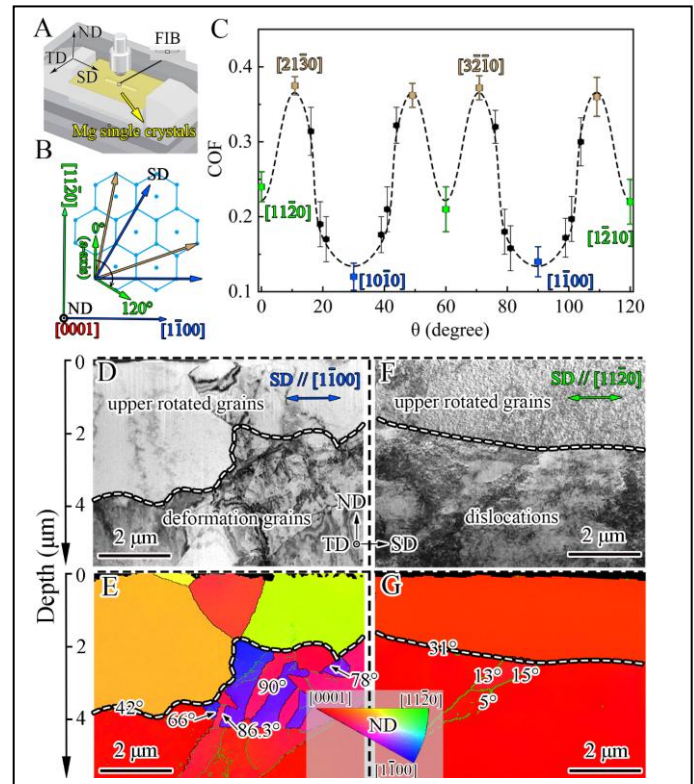
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ABSTRACT

One-fourth of the global energy losses are spent to overcome friction, making it particularly important to reduce and minimize friction between contacting materials. Hexagonal close-packed (HCP) metals are an important class of structural materials. It has not been possible to reduce their friction, primarily because of friction-induced dislocation slip and twinning. Here, we find particularly low friction when sliding perpendicular to the *a*-axis on the basal plane in HCP Mg single crystals (Fig.1A-C). This is in contrast to the common belief that friction is small along the preferred dislocation slip direction (*a*-axis). This macroscopic low-friction stems from twinning assisted lattice reconstruction sharing a common rotation axis, confirmed by atomistic simulations and strain energy analysis. While sliding along the *a*-axis and other directions, $\langle c+a \rangle$ dislocation activity accounts for high frictional resistance (Fig.1D). By unambiguously decoupling the contributions of dislocation slip and twinning, this discovery reveals potential opportunities in mitigating the energy dissipation at tribological interfaces of HCP metals, e.g. through crystallographic texture design.

Fig.1 Figure caption

Direction-dependent friction anisotropy and friction-induced subsurface microstructure of magnesium single crystals. (A) Schematic of the tribometer setup. (B) Schematic illustration of the sliding direction geometry on the basal plane. The sliding directions were chosen along different angles (from 0 to 120°) with respect to $[11\bar{2}0]$ (*a*-



axis). (C) The measured COFs as a function of the degree with respect to the *a*-axis on the basal plane after one sliding cycle. Note that $[11\bar{0}0]$ is 90° with respect to $[11\bar{2}0]$. (D-G) TEM images (D and F) and corresponding crystallographic orientation data (E and G) of the subsurface layers for the samples sliding along $[11\bar{0}0]$ and $[11\bar{2}0]$, respectively.

REFERENCES

- [1] Yong Li, Xiang Chen et al., Under review