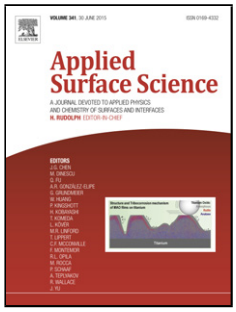

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Boron doped *bcc*-W films: Achieving excellent mechanical properties and tribological performance by regulating substrate bias voltage

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Highlights

- B doped *bcc*-W films were grown by magnetron co-sputtering W and B targets.
- Phase transition from γ-W_2B+α-W(B) to α-W(B) was observed with increasing V_b.
- 6.7 at.% B doped *bcc*-W film shows twice higher hardness than pure W.
- α-W(B) film possesses very low friction coefficient of ~0.18.

Abstract

Boron doped *bcc*-W (WB_x, x=B/W) films were deposited on Si(100) substrates by magnetron co-sputtering pure W and B targets. Our results reveal that when the absolute value of substrate bias voltage (V_b) increases from floating to 240 V, the value of x monotonously decreases from 0.18 to 0.04, accompanied by a phase transition from a mixture of tetragonal γ-W_2B and body-centered cubic α-W(B) phase ($-V_b \leq 60$ V) to α-W(B) single phase ($-V_b > 60$ V). Hardness, depending on V_b, increases first and then drops, where the maximum hardness of 30.8 GPa was obtained at $-V_b$ =60 V and far higher than pure W and W_2B theoretical value. In the mixed phase structure, the grain boundaries strengthening, Hall-Petch effect and solid-solution strengthening induced by B dominate