



## 论文摘要

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### 热压碳化硼表面自润滑膜的生成

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**摘要:** 研究了热压碳化硼表面自润滑膜的生成. 在实验条件下, 未经热处理的碳化硼摩擦副的摩擦因数由起始阶段的0.35-0.40, 随滑行距离的增加而减小至0.25左右. 对摩擦前后接触面进行X射线衍射分析, 结果表明: 接触界面发生了摩擦化学反应, 生成了 $B_2O_3$ ,  $H_3BO_3$ ; 由于 $H_3BO_3$ 具有层状原子结构, 有润滑性, 这是使摩擦因数降低的主要原因; 利用热处理的方法, 促使碳化硼表面生成氧化膜 $B_2O_3$ , 在冷却过程中 $B_2O_3$ 自发地与空气中的水蒸气反应生成 $H_3BO_3$ 自润滑膜, 可使摩擦因数进一步降低至0.08左右, 且更加稳定.

**关键字:** 碳化硼; 摩擦因数; 自润滑; 表面膜

### Formation of self-lubricating surface films on hot-pressed boron carbide

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**Abstract:** In this paper, the authors describe the formation and self-lubricating mechanisms of a surface film on hot-pressed boron carbide ceramic. Under the test condition, the sliding friction coefficients of as-received  $B_4C/B_4C$  ring-on ring pair are quite high at 0.35~0.40 and then decrease with sliding distance to 0.25 as the tribochemical reaction produces  $B_2O_3/H_3BO_3$  film on sliding surface. To induce a complete film forming on the sliding surface can make the friction coefficients decrease further. The annealing heat-treatment is a simple method.  $B_4C$  undergoes oxidation and forms a layer of boron oxide ( $B_2O_3$ ) in the upper surface. While cooling to room temperature, the  $B_2O_3$  reacts with moisture in the air to form a secondary film, boric acid ( $H_3BO_3$ ). The sliding friction coefficient of  $B_4C$  pair after annealing is as low as 0.08. The low-friction mechanism of boron acid is associated with its layered-triclinic-crystal structure. The atoms on each layer are closely packed and strongly bonded to each other but the layers are widely separated and are held together by van der Waals force. During sliding, these atomic layers can align themselves parallel to the direction of relative motion and slide over one another to provide low friction coefficients reported here.

**Key words:** boron carbide; friction coefficient; self-lubrication; surface film

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