FCVAD 技术制备 CrCN 薄膜的热稳定性研究

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摘 要:磁过滤真空阴极弧沉积(FCVAD)技术制备的 CrCN 薄膜具有优异的机械性能,可作为表面改性膜应用于纺织器材、pcb 钻头和活塞环中。本文针对薄膜因摩擦产生高温或应用环境温度高,其结构和性能将发生变化的情况,研究了 CrCN 薄膜的热稳定性。通过 X 射线衍射(XRD)、场发射扫描电子显微镜(FESEM)、拉曼光谱(Raman)和 X 射线光电子能谱(XPS)对常温至 800℃下薄膜的结构进行了表征。结果显示:FCVAD 技术制备的 CrCN 薄膜热稳定上限温度约为 400℃。温度在 400℃以下时,CrCN 薄膜结构稳定,保持无序状态;当温度达到 500℃时,薄膜表面出现细小晶粒,薄膜中的 CrN 相转化为 Cr_2N 相;随着温度继续升高,CrCN 固溶相开始石墨化,薄膜内晶粒尺寸变大;当温度大于 700℃时,薄膜中的碳以 CO 或 CO_2 的形式脱离薄膜,Cr 元素以 Cr_2O_3 相的形式存在,并在 800℃长成尺寸约 400nm 的晶粒。

关 键 词:FCVAD 技术;CrCN 薄膜;热稳定性

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Study on Thermal Stability of CrCN Films Prepared by FCVAD Technology

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Abstract: CrCN films prepared by magnetic filtration cathodic arc deposition (FCVAD)technology have excellent mechanical properties and can be used as surface modified films in textile equipment, pcb drill bits and piston rings. In this paper, the thermal stability of CrCN films was investigated for the situation that the structure and properties of films will change due to high temperature caused by friction or high temperature of application environment. Structure of the films from room temperature to 800℃ was characterized by X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), Raman spectroscopy (Raman), and X-ray photoelectron spectroscopy (XPS). The results show that the upper limit of thermal stability of CrCN films prepared by FCVAD technique is about 400℃. When the temperature is below 400℃, the structure of CrCN films is stable and remains disordered. When the temperature reaches 500℃, fine grains appear on the surface of the films, and the CrN phase in the films is transformed into Cr_2N phase. As the temperature continues to increase, the CrCN solid solution phase starts to graphitize, and the grain size within the films becomes larger. When the temperature is greater than 700℃, carbon in the films leaves in the form of CO or CO_2, and Cr element exists in the form of Cr_2O_3 phase and grows into grains with a size of about 400nm at 800℃.

Key words: FCVAD technology; CrCN thin film; thermal stability

CrN 薄膜因具有高硬度、耐磨损和抗腐蚀等性能而得到广泛应用[1-3]。CrN 薄膜的摩擦系数约为 0.7[4],当薄膜为摩擦副的表面时,会因摩擦而发热,导致耐磨性和耐腐蚀性等降低。为了降低摩擦,改善其性能,常在氮化物薄膜中掺杂 C[5]。GUAN 等在之前的研究中,采用磁过滤真空阴极

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