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研究论文

衬底偏压对线性离子束DLC膜微结构和物性的影响

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摘要:

采用一种新型线性离子束PVD技术制备出大面积类金刚石薄膜(DLC膜), 研究了衬底负偏压对薄膜微结构和物性的影响. 结果表明: 制备出的类金刚石薄膜在300 mm × 100 mm 范围内纵向厚度均方差约10--12 nm, 横向薄膜厚度均方差约2--4 nm. 随着衬底偏压的提高, 薄膜中sp^3键的含量先增加后减小, 在衬底偏压为-100 V时sp^{3}键的含量最大; DLC膜的残余应力、硬度和弹性模量与sp^3键的含量呈近似线性的关系, 在衬底偏压为-100 V时其最大值分别为3.1 GPa、26 GPa和230 GPa. DLC薄膜的摩擦学性能与薄膜中sp^3碳杂化键的含量密切相关, 但是受衬底偏压的影响不大, 其摩擦系数大多小于0.25. 偏压对磨损的影响很大, 在偏压比较低(0– -200 V)时, 薄膜的磨损率约为10^{-8} mm^3/N ?m, 偏压升高到300 V磨损率急剧提高到10^{-7} mm^3/N ? m.

关键词: 无机非金属材料 线性离子束 DLC薄膜 微结构 力学性能 摩擦性能

Effect of substrate bias on microstructure and properties of diamond-like carbon films by linear ion beam system

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Abstract:

A large area diamond-like carbon films were synthesized on P type Si(100) substrates, ranged in 300 mm×100 mm matrix, by an advanced linear ion beam system using the precursor gas of acetylene. Effect of substrate negative bias on the microstructure and properties of DLC films were investigated by Raman spectroscopy, stress tester and nano-indenter respectively. The tribological behavior of films was also investigated by a homemade ball-on-disk tribometer. With increasing the bias from 0 to 300 V, the G-peak position of the Raman spectra decreased firstly and then increased. A lowest value was acquired at the bias voltage of −100 V, which represented the highest sp3 fraction in the DLC films. The highest residual stress, hardness and Young s modulus films of were also observed when the negative bias voltage was −100 V, respectively. The DLC films deposited with bias voltage 300 V showed the largest wear rate than the others.

Keywords: inorganic non-metallic materials Linear ion beam diamond-like carbon microstructure properties

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