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论文

电弧离子镀法制备高硬度Cr-Si-C-N薄膜

聂朝胤[1, 2], Akiro Ando[2], 卢春灿[1], 贾晓芳[1]

1) 西南大学材料科学与工程学院, 重庆 400715
2) Ion Engineering Research Institute Corporation, Osaka 573-0128, Japan

摘要:

采用电弧离子反应沉积技术在SCM415渗碳淬火钢基片上沉积了Cr-Si-C-N薄膜, 三甲基硅烷(TMS)反应气体作为Si和C掺杂源, 通过改变TMS流量实现了薄膜中Si和C含量的调节. 利用XPS, XRD, HRTEM和显微硬度计研究了Cr-Si-C-N薄膜的化学状态、显微组织和显微硬度. Cr-Si-C-N薄膜中的Si和C含量随TMS流量的增加而单调增加. 在TMS流量小于90 mL/min时, 薄膜中 Si和C含量较少, 薄膜由Cr(C, N)纳米晶与Si_3N_4非晶(nc-Cr(C, N)/a-Si_3N_4)组成, 薄膜硬度随流量的增加而单调增大, 最大至4500 HK. 硬度的增加源于固溶强化及薄膜中纳米晶/非晶复合结构的形成; 当TMS流量大于90 mL/min时, 薄膜中Si和C 含量较多, 多余的C以游离态形式存在, 且随TMS流量的增加而增多, 薄膜硬度下降.

关键词: 电弧离子镀 Cr-Si-C-N薄膜 纳米晶 显微硬度

Cr--Si--C--N HARD FILMS PREPARED BY ARC ION DEPOSITION METHOD

NIE Chaoyin[1, 2], Akiro Ando[2], LU Chuncan[1], JIA Xiaofang[1]

1) School of Materials Science and Engineering, Southwest University, Chongqing 400715
2) Ion Engineering Research Institute Corporation, Osaka 573-0128, Japan

Abstract:

PVD or CVD Me-Si-N nanocomposite films synthesized by doping Si element in metallic nitride matrix have exhibited good oxidation resistance and wear resistance. As melting the alloy target containing Si is not easy, it is difficulty to dope much more Si in the films by PVD techniques. In addition, the Me-Si-N films do not have enough lubrication. In this paper, Cr-Si-C-N films were prepared by cathode arc ion deposition technique, in which tetramethylsilane (TMS) was used as Si and C sources, and their concentrations in the Cr-Si-C-N films can be controlled by TMS flow. The state of chemical bonding, microstructure and microhardness were investigated by XPS, XRD, HRTEM and microindentation hardness tester. Results show that the Si and C contents increase monotonicly with the increase of TMS flow. When the TMS flow is lower than\linebreak 90 mL/min, the Cr-Si-C-N film has a composite structure of Cr(C, N) nanocrystals dispersing in the amorphous Si_3N_4 (nc-Cr(C, N)/a-Si_3N_4), and the microhardness increases to 4500 HK with increasing TMS flow. Such high hardness originates from the solid solution hardening of the doping fewer element and the Veprek nanocomposite structure hardening mechanism. With the further increase of TMS flow, the hardness decreases because of the appearance of free C.

Keywords: cathode arc ion deposition;Cr-Si-N film;Cr-Si-C-N film;TMS;microhardness

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通讯作者: 聂朝胤

作者简介: 聂朝胤, 男, 1964年生, 教授, 博士

作者Email: niecy@swu.edu.cn

参考文献:

[1] Gun Y H, Cheng H H. Mater Sci Eng, 2001; A318: 155
[2] Berg G, Friedrich C, Broszeit E, Berger C. Surf Coat Technol, 1996; 86–87: 184

[3] Diserens M, Patscheider J, L´evy F. Surf Coat Technol, 1999; 120–121: 158
[4] Vaz F, Rebouta L, Goudeau P, Pacaud J, Garem H,
Rivi`ere J P, Cavaleiro A, Alves E. Surf Coat Technol, 2000; 133–134: 307
[5] Zhang G, Wang L, Wang S C, Yan P, Xue O J. Appl Surf Sci, 2009; 255: 4425
[6] Nie C Y, Ando A, Watanabe H, Ohtani S. J Surf Finish Soc Jpn, 2004; 55: 286
[7] Lee S Y, Hong Y S. Surf Coat Technol, 2007; 202: 1129
[8] Veprek S. Surf Coat Technol, 1997; 97: 15
[9] Veprek S, Argon A S. Surf Coat Technol, 2001: 146–147: 175
[10] Lee H Y, Jung W S, Han J G, Seo S M, Kim J H, Bee Y H. Surf Coat Technol, 2005; 200: 1026
[11] Almer J, Od´en M, H´akansson G. Thin Solid Films, 2001; 385: 190
[12] Benkahoul M, Robin P, Gujrathi S C, Martinu L, Klemberg–Sapieha J E. Surf Coat Technol, 2008; 202: 3975

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1．何国, 边赞, 陈国良 .Zr52.5Ni14.6Al10Cu17.9Ti5块体玻璃合金等温晶化与结构转变[J]. 金属学报, 1999,35(5): 458-462
2．朱文辉, 朱敏, 罗堪昌 .高能球磨在MmNi5-x（Co,Al,Mn）x / Mg体系中诱发的固态反应及纳米相复合储氢合金的形成[J]. 金属学报, 1999,35(5): 541-545
3．甘阳, 周本濂 .FeMoSiB纳米晶薄带的裂纹扩展阻力和结构的关系[J]. 金属学报, 2001,37(4): 391-394
4．谢丹, 汪明朴, 齐卫宏, 曹玲飞 .金属纳米晶体熔化与过热的等效模型[J]. 金属学报, 2005,41(5): 458-462
5．柯培玲, 武颖娜, 王启民, 宫骏, 孙超, 闻立时 .爆炸喷涂空心球形氧化锆热障涂层的抗热冲击性能[J]. 金属学报, 2004,40(11): 1179-1182
6．王启民, 武颖娜, 柯培玲, 纪爱玲, 孙, 超, 黄荣芳, 闻立时 .电弧离子镀Ni--Co--Cr--Al--Y--Si--B涂层的热腐蚀性能[J]. 金属学报, 2004,40(4): 399-403
7．许云华, 陈渝眉, 熊建龙, 朱金华 .冲击载荷下应变诱导高锰钢表层组织纳米化机制[J]. 金属学报, 2001,37(2): 165-170
8．汪宏斌, 王晓宇, 张骥华, 徐祖耀 .纳米晶Fe-25%Ni合金块材的内耗研究[J]. 金属学报, 2004,40(5): 523-526
9．钟伟荣, 邵元智, 林光明, 胡西多 .双相软磁合金晶间非晶相Curie温度的增强效应[J]. 金属学报, 2004,40(8): 795-798
10．邹友生, 汪伟, 郑静地, 孙超, 黄荣芳, 闻立时 .偏压对电弧离子镀沉积类金刚石膜的影响[J]. 金属学报, 2004,40(5): 537-540
