聚酰亚胺杂化薄膜的制备与表征

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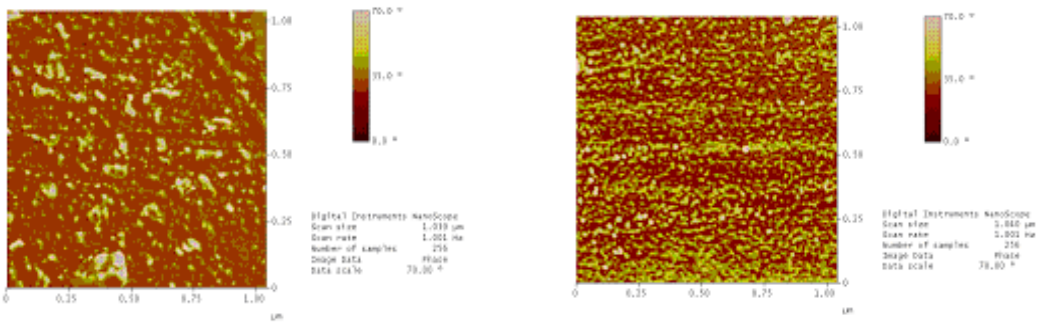
关键词：聚酰亚胺薄膜 杂化 吸水率

聚酰亚胺作为一种典型的工程材料由于其优异的性能例如高耐热、高强度，特别是较低的介电常数正广泛应用于航空航天、核工业和微电子等领域。但是实际应用发现聚酰亚胺材料自身具有高吸湿性、高热膨胀系数等缺点。并且随着一些新应用如设备的不断小型化和变频调速技术对材料提出了更高的、更苛刻的要求，这样就要求具有更好性能的材料来代替原有的材料。通常无机材料具有一些优异的性能，实践已证明在有机基体树脂中加入无机材料将会产生一种新的杂化材料，无机组分将大大地改善有机材料的性能，并在一定程度上综合有机和无机两组分各自的特征和优点。为了获得这种杂化材料，溶胶-凝胶路线是可行并且是目前获得杂化材料的一种重要方法。为了增强无机和有机两组分间的相容性和相互作用力，引入偶联剂可以达到这一目的，并且偶联剂的引入将对材料的结构和性能产生很大的影响[1-3]。本文采用溶胶-凝胶法制备了聚酰亚胺杂化薄膜，并研究了无机组分的引入对薄膜吸水率的影响。通过掺杂得到一吸湿性略有改善的产品，并且其吸水率随无机组分含量的增加呈下降趋势。

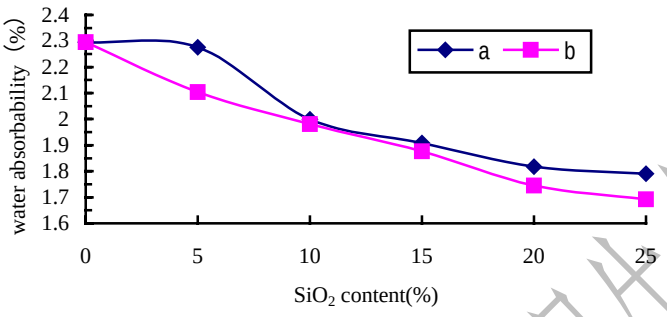
图 1 给出了杂化薄膜的原子力显微镜图像。由图可知采用溶胶-凝胶技术能够把无机组分比较均匀地分散到有机基体树脂中，得到一“ 镶嵌型 ”结构。比较（a)、(b）图像可知，无机粒子尺寸明显减少，分散更均匀，团聚减弱，粒径分布变窄。



(a) PI/SiO_2 without coupling agent　　(b) PI/SiO_2 with coupling agent

Fig.1 AFM phase images of the hybrid films

图 2 给出了加入含有不同 SiO_2 含量的 PI 杂化薄膜的吸水率曲线。由图可知引入无机组分之后薄膜的吸水率有所下降。



(a: the hybrid system without coupling agent, b: the hybrid system with coupling agent)
Fig.2 Curves for water absorbability of the films with SiO_2 content

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Preparation and characterization of polyimide hybrid film

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Abstract: In this paper, a kind of doped polyimide film was made by synthesizing polyimide/inorganic -particle matrix resin through sol-gel technique, followed by rotating it on a silex glass plate and heating at high temperature. The effect of the inorganic component that derived from methyl-triethoxysilane, as a precursor of the inorganic moiety, in-situ in the polyamic acid solution on water absorbability of the film was studied. And the miscibility between the organic and inorganic phases and its effect on the property were investigated with aminopropyltriethoxysilane, which served as a coupling agent, added into the polyimide composite system. The surface morphology of the film was characterized by AFM. It proved that the water absorbability decreased with the increase of the content of the inorganic particle. It also turned out that the presence of chemical bonds between two phases due to addition of the coupling agent had, to some extent, effect on the water absorbability of the film.

Key words: polyimide；morphology；water absorbability；hybrid film

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摘要 用均苯四甲酸二酐（PMDA）和 4,4’-二氨基二苯醚（ODA）合成聚酰亚胺基体树脂，以甲基三乙氧基硅烷（MTEOS）为无机前驱体原位产生二氧化硅粒子，并以３－氨丙基三乙氧基硅烷（APrTEOS）为偶联剂制备了聚酰亚胺/二氧化硅杂化薄膜。采用原子力显微镜（AFM）表征了杂化薄膜的界面形态，并分析和讨论了无机成份的含量和两相间界面形态的变化对薄膜吸水率的影响。结果表明无机组份的引入将对杂化薄膜的吸水率产生一定的影响，薄膜的吸水率随二氧化硅含量的增加而降低；偶联剂的引入对无机粒子的分散、两相间相容性及界面形态具有明显的改善作用。

关键词 聚酰亚胺 杂化 偶联剂 吸水率