原子核物理评论　2006 23 (2): 198-201　ISSN: 1007-4627　CN: 62-1131/O4

核材料与粒子辐射效应

离子注入/辐照引起Al2O3单晶的改性研究

宋银,张崇宏,王志光,赵志明,姚存峰,周丽宏,金运范

中国科学院近代物理研究所,甘肃兰州730000

收稿日期　修回日期　网络版发布日期　接受日期

摘要

600K温度下用110keV的He^＋，Ne^＋，Ar^＋离子注入及320K温度下用230MeV的^208Pb^27＋辐照Al2O3单晶样品，研究了离子注入和辐照对Al2O3单晶样品结构和光学特性的影响。从测得的光致发光谱可以清楚地看到，所有样品在波长为375，413和450nm处出现了强的发光峰。且所有5×10^16ion/cm^2注入样品的发光峰均最强。经过高能Pb辐照后的样品，在390nm处出现了新的发光峰。透射电镜分析发现在注入氖样品100nm入射深度以内形成了高浓度的小空洞（1-2nm），在Ne沉积区域有少量大空洞形成。傅立叶变换红外光谱分析发现，波数在460-510cm^-1间的振动吸收带经过离子辐照后展宽，随着辐照量的增大，该振动吸收强度显著减弱。1000—1300cm^-1对应Al-O-Al桥氧伸缩振动模式的吸收带，辐照后向高波数方向移动。对离子注入和辐照对Al2O3单晶样品结构损伤机理进行了初步探讨。

Single crystal sapphire （Al2O3 ） samples were implanted at 600 K by He, Ne and Ar ions with energy of 110 keV to doses ranging from 5 × 10^16 to 2× 10^17 ion/cm^2 or irradiated at 320 K by ^208Pb^27＋ ion with energy of 1.1 MeV/u to the fluences ranging from 1 × 10^12 to 5 × 10^14 ion/cm^2. The modification of structure and optical properties induced by ion implantation or irradiation were analyzed by using photoluminescence（PL） and Fourier transformation infrared spectrum（FIR） spectra and transmission electron microscopy （ TEM ） measurements. The PL measurements showed that absorption peaks located at 375,413 and 450 nm appeared in all the implanted or irradiated samples, the PL intensities reached up to the maximum for the 5 × 10^16 ion/cm^2 implanted samples. After Pb-ion irradiation, a new peak located at 390 nm formed. TEM analyses showed that small size voids,（ 1--2 nm） with high density were formed in the region from the surface till to about 100 nm in depth and also large size Nebubble formed in the Ne-doped region. From the obtained FTIR spectra, it was found that Pb-ion irradiation induced broadening of the absorption band in 460-510 cm^-1 and position shift of the absorption band in 1 000- 1 300 cm^- 1 towards to high wavenumber. The possible damage mechanism in single crystal sapphire induced by energetic ion implantation or irradiation was briefly discussed.

关键词　离子注入　重离子辐照　Al2O3 光致发光谱　透射电镜分析　红外光谱

分类号

DOI:

通讯作者:

作者个人主页: 宋银;张崇宏;王志光;赵志明;姚存峰;周丽宏;金运范