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材料合成及性能

Fe、Ni共掺杂ZnO基稀磁半导体光学性能与铁磁性研究

魏智强[1,2], 张玲玲[1], 武晓娟[1], 吴永富[1], 王璇[1]
1. 兰州理工大学 理学院, 甘肃 兰州 730050;
2. 兰州理工大学 甘肃省有色金属新材料省部共建国家重点实验室, 甘肃 兰州 730050

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摘要： 采用水热法成功制备了不同掺杂浓度的$Zn_{1-2x}Fe_xNi_xO$（x=0，0.025，0.05，0.1）稀磁半导体材料，利用X射线衍射（XRD）、透射电子显微镜（TEM）和X射线能量色散分析仪（XEDS）对样品进行表征，并结合拉曼（Raman）光谱、光致发光光谱（PL）和振动样品磁强计（VSM）研究样品的光学性能和磁学性能。结果表明，水热法制备的样品具有结晶性良好的纤锌矿结构，没有杂峰出现，形貌为纳米棒状结构，分散性良好。Fe^{2+}、Ni^{2+}是以替代的形式进入ZnO晶格中，Fe和Ni的掺杂使得晶体中的缺陷和应力增加，拉曼光谱峰位发生红移，光致发光光谱发生猝灭现象。另外，共掺杂样品在室温条件下存在明显的铁磁性，饱和磁化强度随着掺杂量的增加而增强。

关键词： 共掺杂ZnO 水热法 光学性能 铁磁性

Optical Properties and Ferromagnetism of Fe and Ni Co-doped ZnO Dilute Magnetic Semiconductors

WEI Zhi-qiang[1,2], ZHANG Ling-ling[1], WU Xiao-juan[1], WU Yong-fu[1], WANG Xuan[1]
1. School of Science, Lanzhou University of Technology, Lanzhou 730050, China;
2. State Key Laboratory of Gansu Advanced Non-ferrous Metal Materials, Lanzhou University of Technology, Lanzhou 730050, China

Abstract: Diluted magnetic semiconductors $Zn_{1-2x}Fe_xNi_xO$ with different consistency ratio (x=0,0.025, 0.05, 0.1) have been synthesized by hydrothermal method.The samples were characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM) and X-ray energy dispersive spectrometry (XEDS), and the optical and magnetic properties of the products were investigated by Raman scattering spectra (Raman), photoluminescence spectra (PL) and vibrating sample magnetometer (VSM).The experiment results show that all samples synthesized by this method possess wurtzite structure with good crystallization, no other impurity phase appeared, and the morphology are nanorods and well dispersed. All the Fe^{2+} and Ni^{2+} successfully substituted for the lattice site of Zn^{2+} and generate single-phase $Zn_{1-2x}Fe_xNi_xO$, Raman spectra occurred red shift and the photoluminescence intensity were quenched due to the crystal defects and internal stress increase with iron and nickel co-doping. In addition, the obvious ferromagnetic was found in all samples at room temperature, and the saturation magnetization enhanced with the increase of iron and nickel doping content.

Keywords: co-doped ZnO hydrothermal method optical properties ferromagnetism

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通讯作者: 魏智强

作者简介: 魏智强（1973- ），男，甘肃会宁人，教授，2007年于兰州理工大学获得博士学位，主要从事纳米薄膜及纳米粉体材料的制备、性能表征和应用，材料表面改性等方面的研究。E-mail:zqwei7411@163.com

作者Email: zqwei7411@163.com

参考文献：

[1] Young M C ,Woon G K C. Effects of rapid thermal annealing on the ferromagnetic properties of sputtered $Zn_{1-x}(Co_{0.5}Fe_{0.5})_xO$ thin films [J]. *Appl. Phys. Lett.*, 2002, 80(18):3358-3360.

[2] Jayakumar O D, Gopalakrishnan I K, Shashikala K, *et al.* Magnetization study of Fe-doped ZnO co-doped with Cu:Synthesized by wet chemical method [J]. *Mater. Sci.*, 2006, 41(15):4706-4712.

[3] Yao Y H, Cao Q X. First-principles study on infrared absorption of transition metal-doped ZnO with oxygen vacancy [J]. *Acta Metal.Sinica (English Lett.)*, 2013, 26(4):467-472.

[4] Ryu M K, Lee S H, Jang M S, *et al.* Postgrow thannealing effect on structural and optical properties of ZnO films grow on GaAs substrates by the radio frequency magnetron sputtering technique [J]. *J. Appl. Phys.*, 2002, 92(1):154-158.

[5] Ahn G Y, Park S I, Kim S J, *et al.* Ferromagnetic properties of Fe-substituted ZnO-based magnetic semiconductor [J]. *J. Magn. Magn. Mater.*,

[6] Fu T H, Gao Q Q, Liu F, *et al.* Preparation of (Fe,Ni)-codoped ZnO and its photocalytic activity for degradation of methyl orange [J]. *Chin. J. Catalysis (催化学报)*, 2010, 31(7):797-802 (in Chinese).

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[7] Hu Z G, Duan M Y, Xu M, *et al.* Electronic structure and optical properties of ZnO doped with Fe and Ni [J]. *Acta Phys. Sinica (物理学报),* 2009, 58(2):1166-1172 (in Chinese).

[8] Peng K, Zhou L P, Hu A P, *et al.* Room temperature ferromagnetism in $Zn_{1-x}Ni_xO$ diluted magnetic semiconductor [J]. *Chin. J. Nonferrous Metals (有色金属学报),* 2007, 17(1):35-38 (in Chinese).

[9] Jun M C, Park S U, Koh J H. Comparative studies of Al-doped ZnO and Ga-doped ZnO transparent conducting oxide thin films [J]. *Nanoscale Res. Lett.,* 2012, 7:639-644.

[10] Calizo I, Balandin A A, Bao W, *et al.* Temperature dependence of the raman spectra of grapheme and grapheme multilayers [J]. *Nano Lett.,* 2007, 7(9):2645-2649.

[11] Wang X, Li Q, Liu Z, *et al.* Low-temperature growth and properties of ZnO nanowires [J]. *Appl. Phys. Lett.,* 2004, 84(24):4941-4943.

[12] Decremps F, Porres J P, Saitta A M, *et al.* High-pressure Raman spectroscopy study of wurtzite ZnO [J]. *Phys. Rev.* B.2002, 65(9):092101-1

[13] Ni S L, Chang Y Q, Duo Y Z, *et al.* Raman and photoluminescence properties of Mn doped ZnO nanowires [J]. *J. Funct. Mater.(功能材料),* 2007, 38(8):1380-1381 (in Chinese).

[14] Cong G W, Wei H Y, Zhang P F, *et al.* One-step growth of ZnO from film to vertically well-aligned nanorods and the morphology-dependent Raman scattering [J]. *Appl. Phys. Lett.,* 2005, 87(23):231903-1-3.

[15] Limaye M V, Singh S B, Das R, *et al.* Room temperature ferromagnetism in undoped and Fe doped ZnO nanords: Microwave-assisted synthesis [J]. *J. Solid State Chem.,* 2011, 184(2):391-400.

[16] Liu C, Yun F, Morkoc H. Ferromagnetism of ZnO and GaN: A review [J]. *J. Mater. Sci. Mater. Electron.,* 2005, 16(9):555-597.