材料研究学报 2011, 25(1) 32-38 DOI: ISSN: 1005-3093 CN: 21-1328/TG

研究论文

La2O3 -Y2O3-ZrO2纳米陶瓷粉末制备及高温相稳定性

何轶伦, 周伍喜, 李松林, 刘怀菲, 赖天苗, 汤盛龙

中南大学粉末冶金国家重点实验室 长沙 410083

摘要: 用化学共沉淀法制备4.5%Y2O3--ZrO2(YSZ)和0.6% La2O3--YSZ、0.8% La2O3--YSZ、1.2% La2O3--YSZ(0.6La、0.8La、1.2La)(摩尔分数)纳米复合陶瓷粉末, 研究了四组粉末的高温相稳定性。结果表明: 采用正向滴淀方法制备的0.6La粉末(粒径~50 nm)团聚严重, 而用反向滴淀方法制备的0.6La粉末(粒径~20 nm), 粉末团聚少; 各组前躯体粉末在600℃煅烧2 h后都呈单一四方相结构; 在1200℃烧结100 h后0.6La、0.8La坯体呈单一四方相结构, 无相变, YSZ和1.2La坯体都有立方相且1.2La坯体有锆酸镧相生成; 在1300℃烧结100 h后0.6La, 0.8La, 1.2La坯体呈四方相和立方相结构, 其中1.2La坯体有锆酸镧相生成, 在相同条件下烧结的YSZ坯体有少量(~1.5\%)单斜相产生; 在1400℃烧结100 h后各组份中四方相已不能保持稳定, 转化为单斜相和立方相, 0.6La、0.8La、1.2La、YSZ坯体单斜相含量分别为30.5%, 32%, 35%, 46.0%。在YSZ中添加少量La2O3在1300℃烧结能有效改善其高温相的稳定性。

关键词: 无机非金属材料 稀土共掺杂二氧化锆 纳米粉末 共沉淀 相稳定性

Preparation and High Temperature Phase Stability of La2O3－Y2O3－ZrO2 Composite Ceramic Nanopowder

HE Yilun ZHOU, Wuxi LI Songlin, LIU Huaifei, LAI Tianmiao, TANG Shenglong

State Key Laboratory of Powder Metallurgy, Central South University, Changsha 410083

Abstract: 4.5%Y2O3－ZrO2, 0.6%La2O3－YSZ, 0.8%La2O3－YSZ, 1.2%La2O3－YSZ (YSZ, 0.6La, 0.8La, 1.2La) (molar fraction) composite ceramic nanopowders were prepared by co－precipitation method using ZrOCl2 • 8H2O, Y(NO3)3 • 6H2O, La2O3 as raw materials. The synthesized powders were characterized and the phase stability was investigated. The results show that the size of 0.6La particles prepared by reverse titration method is ～20 nm, and the size of particles prepared by the straight titration method is ～50 nm. The agglomeration of the powder prepared by reverse titration method is also smaller than that of the powder prepared by straight titration method. After calcined at 600°C for 2 h, all of the synthesized powders showed the pure tetragonal structure; after sintered at 1200°C for 100 h, 0.6La, 0.8La showed the pure tetragonal structure, the cubic phase composed of both of YSZ and 1.2La and pyrochlore structure compose of 1.2La; after sintered at 1300 for 100 h, 0.6La, 0.8La, 1.2La showed the tetragonal structure, the cubic phase compose of all synthesized powders and pyrochlore structure compose of 1.2La and small fraction of monoclinic phase (～1.5%) was formed of YSZ; after sintered at 1400°C for 100h, the tetragonal phase cannot keep stable, monoclinic phase compose of all the synthesized powders, the monoclinic phase content of 0.6La, 0.8La, 1.2La, YSZ is 30.5%, 32%, 35%, 46.0% respectively. The phase stability of YSZ can be modified by addition small fraction of La2O3 at 1300°C.

Keywords: inorganic non－metallic materials rare－earth co－doped zirconia nanopowder co－precipitation phase stability

收稿日期 2010-05-20 **修回日期** 2010-12-12 **网络版发布日期** 2011-02-25

DOI:

基金项目:

教育部新世纪优秀人才支持计划CET--06--0683和湖南省121优秀人才支持计划08--030329资助项目。

通讯作者: 何轶伦

作者简介:

通讯作者E-mail: lisl@mail.csu.edu.cn

参考文献：

[1] M.Matsumoto, K.Aoyama, H.Matsubara, K.Takayama, T.Banno, Y.Kagiya, Y.Sugita, Thermal conductivity and phase stability of plasma sprayed ZrO2-Y2O3-La2O3 coatings, Surface and Coating Technology, 194, 31(2005)

[2] M.Matsumoto, N.Yamaguchi, H.Matsubara, Low thermal conductivity and high temperature stability of ZrO2-Y2O3-La2O3 coatings produced by electron beam PVD, Scripta Materialia, 50, 867(2004)

[3] X.Huang, D.Wang, M.Lamontagne, C.Moreau, Experimental study of the thermal conductivity of metal oxides co-doped yttria stabilized zirconia, Materials Science and Engineering B, 149, 63(2008)

[4] F.M.Pitek, C.G.Levi, Opportunities for TBCs in the ZrO2-YO1.5-TaO2.5 system, Surface & Coatings Technology, 201, 6044(2007)

[5] R.L.Jones, R.F.Reidy, D.Mess, Scandia, yttria-stabilized zirconia for thermal barrier coatings, Surface and Coatings Technology, 82, 70(1996)

[6] M.N.Rahaman, J.R.Gross, R.E.Dutton, H.Wang, Phase stability, sintering, and thermal conductivity of plasma- sprayed ZrO2-Gd2O3 compositions for potential thermal barrier coating applications, Acta Materialia, 54, 1615(2006)

[7] M.Matsumoto, H.Takayama, D.Yokoe, K.Mukai, H.Matsubara, Y.Kagiya, Y.Sugita, Thermal cycle behavior of plasma sprayed La2O3,Y2O3 stabilized ZrO2 coatings, Scripta Materialia, 50, 2035(2006)

[8] H.Dai, X.Zhong, J.Li, Y.Zhang, J.Meng, X.Cao, Thermal stability of double-ceramic-layer thermal barrier coatings with various coating thicknes, Materials Science and Engineering

[9] A, 433, 1(2006)

[10] C.Viazzi, J.P.Bonino, F.Ansart, A.Barnab´e, Structural study of metastable tetragonal YSZ powders produced via sol-gel route, Journal of Alloys and Compounds, 452, 377 (2008)

[11] H.Chen, C.X.Ding, Nanostruetured zirconia coating prepared by atmospheric plasma spraying, Surface and Coatings Technology, 150, 31(2002)

[12] ZHOU Hong, LI Fei, HE Bo, WANG Jun, SUN Baode, Nanostructured yttria stabilized zirconia coatings deposited by air plasma spraying, Transactions of Nonferrous Metals Society of China, 17, 389(2007)

[13] ZHOU Hongming, YI Danqing, Research on preparation and thermophysical properties of Dy2Zr2O7 ceramic powder, Journal of Aeronautical Materials, 28(1), 65(2008)

[14] Y.T.Moon, H.K.Park, D.K.Kim, C.H.Kim, I.S.Seog, Preparation of monodisperse and spherical zirconia powders by heating of alcohol-aqueous salt solution, Journal American Ceramic Society, 78(10), 2690(1995)

[15] Z.C.Michael, E.P.Andrew, H.B.Charls, Sol-gel and ultra-fine particle formation via dielectric tuning of inorganic salt-alcohol-water solutions, Journal of Colloid and Interface

[16] Science, 222(1), 20(2000)

[17] J.Y.Choi, D.K.Kim, Preparation of monodisperse and spherical powders by heating of alcohol-aqueous salt solutions, Journal of Sol-Gel Science and Technology, 15(3),

[18] 1(1999)

[19] H.Chen, Y.Gao, Y.Liu, H.Luo, Coprecipitation synthesis and thermal conductivity of La2Zr2O7, Journal of Alloys and Compounds, 480, 843(2009)

[20] H.Yang, J.Ouyang, X.Zhang, N.Wang, C.Du, Synthesis and optical properties of yttria-doped ZrO2 nanopowders, Journal of Alloys and Compounds, 458, 474(2008)

[21] J.Sun, L.Gao, pH effect on titania-Phase transformation of precipitates from titanium tetrachloride solutions, Journal of American Ceramic Society, 85(9), 2382(2002)

[22] S.G.Chen, Y.S.Yin, D.P.Wang, J.Li, Reduced activation energy and crystalline size for yttria-stabilized zirconia nano-crystals: An experimental and theoretical study, Journal of Crystal Growth, 267, 100(2004)

[23] S.G.Chen, Y.S.Yin, D.P.Wang, Experimental and theoretical investigation on the correlation between aqueous precursors structure and crystalline phases of zirconia, Journal

[24] of Molecular Structure, 690, 181(2004)

[25] GE Rongde, ZHAO Tiancong, Computer simulation on the structure of colloidal aggregates formed during chemical precipitation, Journal of Central South Institute of Mining and Metallurgy, 24(5), 607(1993)

[26] M.Leoni, R.L.Jones, P.Scardi, Phase stability of scandia-yttria-stabilized zirconia TBCs, Surface and Coatings Technology, 108-109, 107(1998)

[27] C.Viazzi, J.P.Bonino, F.Ansrat, A Barnab´e, Structural study of metastable tetragonal YSZ powders produced via sol-gel route, Journal of Alloys and Compounds, 452, 377 (2008)

[28] LIU Huaifei, LI Songlin, LI Qilian, LI Yongming, ZHOU Wuxi, Preparation and phase stability at high temperatures of La2O3, Y2O3 codoped ZrO2 ceramic poeder., Jounal of Inorganic Materials, 24(6), 1(2009)

[29] X.Q.Cao, Application of rare earths in thermal barrier coating materials, Journal of Materials Science and Technology, 23(1), 15(2007)

[30] E.R.Andrievskaya, L.M.Lopato, Influence of composition on the T→M transformation in the systems ZrO2-Ln2O3 (Ln=La, Nd, Sm, Eu), Journal of Materials Science, 30, 2591 (1995)

[31] J.W.Jang, D.J.Kim, D.Y.Lee, Size effect of trivalent oxides on low temperature phase stability of 2Y-TZP, Journal of Materials Science, 36, 5391(2001)

本刊中的类似文章

1．国娜 李亚东.Sm3+掺杂对SmxNiCo0.2Mn1.8O4热敏陶瓷性能的影响[J]. 材料研究学报, 2011,25(2): 209-213

2．吴法宇 张峻巍 周艳文 李维娟.基于双带模型的螺旋炭纤维电导特性[J]. 材料研究学报, 2011,25(2): 187-192

3．王景 苏革 曹立新 柳伟 董征 赵莉丽 宋美芹.钴掺杂对氧化镍薄膜电致变色性能的影响[J]. 材料研究学报, 2011,25(2): 179-182

4．陈一维 张颖 汪大云 韩恩山 .Mn4+--掺杂锂钒氧化物的合成及其电化学性能[J]. 材料研究学报, 2011,25(2): 205-208

5．倪自丰 刘利国 王永光.锡催化生长氧化硅纳米线的制备和表征[J]. 材料研究学报, 2011,25(2): 183-186

6．王延平 王兵 熊鹰 周亮.掺氮纳米金刚石膜的制备和性能[J]. 材料研究学报, 2011,25(2): 147-150

7．齐恩磊 满丽莹 王孙昊 王介强.CeO2纳米棒的微波合成及其光催化性能[J]. 材料研究学报, 2011,25(2): 219-224

8．李万喜 吕宝亮 徐耀 吴东.Fe_3O_4十八面体和十二面体的合成及磁性能[J]. 材料研究学报, 2011,25(2): 141-146

9．钟月锋 万云涛 夏海平.Ni^{2+} 掺杂近化学计量比铌酸锂晶体的近红外发光特性[J]. 材料研究学报, 2011,25(1): 84-88

10．王成 胡作启 伍双杰 王庆 赵旭.La2O3掺杂BST/Mg2TiO4微波复合陶瓷的制备和性能[J]. 材料研究学报,

2011,25(1): 109-112