发光学报 CHINESE JOURNAL OF LUMINESCENCE 中文核心期刊
主管：中国科学院
主办：中国科学院长春光学精密机械与物理研究所 中国物理学会发光分会
主编：申德振



发光学报 2013, 34(10) 1386-1391 ISSN: 1000-7032 CN: 22-1116/O4

发光学应用及交叉前沿

# 表面微结构辐射器几何结构对发射性能的影响

徐继圆, 左国平, 周剑良
南华大学 核科学技术学院, 湖南 衡阳 421001



摘要： 放射性同位素热光伏系统(RTPV)中表面微结构辐射器几何尺寸是决定其发射性能和系统效率的关键因素之一。本文通过对单个钨微腔宽度、高度以及壁厚对辐射器发射性能影响的探讨,初步得出了其红外辐射出射特点的产生原因,并利用时域有限差分算法(FDTD)对不同几何尺寸微腔的发射性能进行了对比。最后结合GaSb量子效率曲线,发现当微腔高度、宽度与壁厚分别为0.8,1.8,0.1 μm时,其发射性能与GaSb匹配程度较好。

关键词： 辐射器 几何尺寸 微腔 发射性能

## Influence of Physical Dimension of The Mircostructural Surface Emitters on Emission Performance

XU Ji-yuan, ZUO Guo-ping, ZHOU Jian-liang
School of Nuclear Science and Technology, University of South China, Hengyang 421001, China

Abstract: The physical dimension of mircostructural surface emitters is one of the key factors which determines the emission performance and system efficiency in radioisotope thermophotovoltaic (RTPV) systems. This paper preliminarily concluded the reasons for the emitters' characteristics of infrared radiation through the exploration of the effects that the width, height and walls' thickness of a single tungsten mircocavity played on the radiator's emission performance. Then the finite-different-time-domain (FDTD) method was utilized to compare the emission performance of microcavities with different sizes. It is found that the emission performance matches well in the GaSb case taking into account of the efficiency curve of GaSb which the width, height and walls' thickness of a single mircocavity are set as 0.8, 1.8, 0.1 μm, respectively.

Keywords: emitter physical dimension mircocavity emission performance
收稿日期 2013-06-21 修回日期 2013-07-12 网络版发布日期
基金项目:

通讯作者: 周剑良, E-mail: 13327341099@189.cn
作者简介: 徐继圆(1989- ), 男, 江苏连云港人, 主要从事辐射防护与环境保护的研究。E-mail: circlexu@126.com
作者Email: 13327341099@189.cn

参考文献:

[1] Geng X. Feasibility Analysis of TPV Technology During Re-entry Process and Preparation of Selective Emitter. Hefei: University of Science and Technology of China, 2011 (in Chinese).

Yang G. The Spectral Control Properties of Representative Micronstructure and Their Application. Harbin: Harbin Institute of Technology, 2011 (in Chinese).

[2] Heinzel A, Boerner V, Gombert A, *et al.* Microstructured tungsten surfaces as selective emitters [J]. *AIP Conf. Proc.,* 1999, 460:191-196.

[3] Maruyama S, Kashiwa T, Yugami H, *et al.* Thermal radiation from two-dimensionally confined modes in microcavities [J]. *Appl. Phys. Lett.,* 2001, 79(9):1393-1395.

[4] Sai H, Kanamori Y, Yugami H. Tuning of the thermal radiation spectrum in the near-infrared region by metallic surface microstructures [J]. *J. Micromech. Microeng.,* 2005(15):243-249.

[5] Celanovic I, Jovanovic N, Kassakian J. Two-dimensional tungsten photonic crystals as selective thermal emitters [J]. *Appl. Phys. Lett.,* 2008, 92(19):193101-1-3.

[6] Lin S Y, Moreno J, Fleming J G. Three-dimensional photonic-crystal emitter for thermal photovoltaic power generation [J]. *Appl. Phys. Lett.,* 2003, 83(2):380-382.

[7] Liu G P, Han Y G, Li Q, *et al.* Theoretical method for simulating thermal spectral properties of microstructured surface [J]. *J. Eng. Thermophys.*(工程热物理学报), 2009, 30(1):111-114 (in Chinese).

[8] Liu G P. Thermal Radiation Spectral Control Properties of Microstructure and Their Application. Nanjing: Nanjing University of Science ＆ Technology, 2008 (in Chinese).

Liu R S. Study on The Preparation and Properties of Rare-earth Photonic-crystal Emitter. Changsha: National University of Defense Technology, 2008 (in Chinese).

[9] Ma F Y, Su J P, Guo M T. Study on the angular dependence of metal mirror microcavities [J]. *J. Optoelectronics · Laser(光电子 · 激光)*,

[10] Yugami H, Sasa H, Yamaguchi M. Thermophotovoltaic systems for civilian and industrial applications in Japan [J]. *Semiconductor Science and Technology,* 2003, 18(5):S239-S246.

[11] Zhou B K, Gao Y Z, Chen C R, *et al. Laser Principle* [M]. 5th ed. Beijing: National Defense Industry Press, 2004 (in Chinese).

[12] Fang R C. *Solid State Spectroscopy* [M]. Hefei: Press of University of Science and Technology of China, 2003:1-10 (in Chinese).

[13] Fraas L M, Samaras J E, Huang H X, *et al.* TPV generators using the radiant tube burner configuration [J]. *Proc. 17th European PV Solar Energy Conf.*(Munich, Germany, 22-6 Oct), 2001.

[14] Sai H, Kamikawa T, Kanamori Y, *et al.* Thermophotovoltaic generation with microstructured tungsten selective emitters [J]. *AIP Conf. Proc.,* 2004(738):206-214.