

论文

用于红外焦平面的正方形孔径球面微透镜阵列研究

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摘要:

针对目前红外焦平面光敏阵列中存在的占空比小、光能利用率低的实际问题,展开了正方形孔径球面微透镜阵列制作及其与红外焦平面阵列集成应用的研究.本文从红外焦平面光敏阵列特点入手,对比分析了正方形孔径相比于传统圆形孔径微透镜阵列在光能利用上的优势.提出正方形孔径微透镜阵列激光直写变剂量曝光制作技术,建立光刻胶曝光数学模型和正方形球面微透镜面型函数,以此为基础,编制直写设备变剂量曝光控制软件;利用长春理工大的学复合坐标激光直写系统和等离子刻蚀机进行相关工艺实验,制作了阵列 256×256 、单元尺寸 $40 \times 40 \mu\text{m}^2$ 、球面半径 $60 \mu\text{m}$ 、单元间距 $1 \mu\text{m}$ 的红外石英微透镜阵列;并将其与相应阵列的碲-镉-汞红外光敏阵列进行集成.结果表明:微透镜的占空比达到95%,红外焦平面光能利用率从原来的60%提高到90%以上.由此得出结论:变剂量曝光制作微透镜技术是可行的,正方形孔径球面微透镜阵列代替圆形孔径微透镜阵列,对于提高红外探测器的灵敏度、信噪比、分辨率等性能具备明显优势.

关键词: 球面微透镜阵列 红外焦平面 正方形孔径 变剂量曝光

Square Aperture Spherical Microlens Array for Infrared Focal Plane

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Abstract:

In allusion to the current practical problem of small duty ratio, low light energy utilization in infrared focal plane array, the manufacture of square aperture spherical microlens array and integrated application with infrared focal plane array are studied. Starting with the character of microlens array in infrared focal plane array, the advantages of square aperture spherical microlens array and round aperture spherical microlens array are compared. The laser direct writing varying dose exposure making technology of square aperture spherical microlens array is proposed, and the mathematical model of photoresist exposure and the square aperture spherical microlens array surface figure functions are established, based on which the direct writing varying dose exposure software is written. Related process experiments are carried out by the model number of laser direct system and plasma etching machine from Changchun University of Science and Technology. The infrared quartz spherical microlens array is made, of which micro-lens element size is $40 \times 40 \mu\text{m}^2$, spherical radius is $60 \mu\text{m}$ and element spacing is $1 \mu\text{m}$, and then is integrated with the square aperture spherical microlens array with infrared photosensitive array. The results show that the duty ratio achieves 95%, and the utilization ratio of light energy increases from original 60% to 90%. It can be concluded that the way using square aperture spherical microlens array instead of the round aperture spherical microlens array can significantly improve sensitivity, signal-to-noise ratio and resolution ratio of the infrared detector.

Keywords: Spherical micro-lens array Infrared focal plane Square aperture Varying dose exposure

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[1] HAN Yan-lin, LIU De-sen, JIANG Xiao-ping. Sqare selffocu-sing lens array and its image[J].Acta

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Photonica Sinica, 2007, 36(2): 221-223. 韩艳玲,刘德森,蒋小平.方形自聚焦透镜元阵列及其成像[J].光子学报,2007,36(2): 221-223.

[2] ZHANG Yu, LIU De-sen. Manufacture of hexagon aperture plane micro-lens array and its basic characteristics[J]. Acta Photonica Sinica, 2008, 37(8): 1639-1641. 张玉,刘德森.六角形孔径平面微透镜阵列的制作及基本特性研究[J].光子学报,2008, 37(8):1639-1641.

[3] KE Cai-jun, YI Jian-xin. Research on microlens array for improving the fill factor of CCD image sensors[J].Infrared and Laser Engineering, 2004, 33(2): 209-212. 柯才军,易新建.提高CCD图像传感器填充因子的微透镜阵列的研究[J].红外与激光工程,2004,33(2):209-212.

[4] LENNER M, KAPLAN A, PALMER R E. Nanoscopic coulomb explosion in ultrafast graphite ablation [J].Applied Physics Letters, 2007, 90(15): 153119.1-153119.3.

[5] FURUMIYA M. A 1/3-in 1.3 M-pixel single-layer electrode CCD with a high-frame-rate skip mode [J].IEEE Transactions on Electron Devices, 2001, 48(9): 1915-1921.

[6] SUN Yan-jun, LENG Yan-bing, DONG Lian-he. Study on antireflective relief periodic structure of sapphire infrared window[J]. Infrared Technology, 2010, 33(2): 92-94. 孙艳军,冷艳冰,董连和.蓝宝石红外窗口抗反射浮雕结构研究[J].红外技术, 2010, 33(2):92-94.

[7] DACHRAOUI H, HUSINSKY W, BETZ G. Ultra-short laser ablation of metals and semiconductors:evidence of ultra-fast Coulomb explosion[J].Applied Physics Letters, 2006, 83(2): 333-336.

[8] ZUO Chao, CHEN Qian, GU Guo-hua. Nonuniformity correction based on unified photoresponse characteristics of infrared focal plane arrays[J] Acta Photonica Sinica, 2011, 40(6): 926-932. 左超,陈钱,顾国华.基于焦平面归一化响应特性的红外非均匀性校正[J].光子学报2011,40(6):926-932.

[9] JIAO Guo-hua, LI Yu-lin, HU Bao-wen. Mirau phase-shifting interferometer for profile measurement microlenses array[J]. Acta Photonica Sinica, 2007, 36(10): 1924-1927. 焦国华,李育林,胡宝文. Mirau相移干涉法测量微透镜阵列面形[J].光子学报,2007,36(10):1924-1927.

[10] LI Ming, CHENG Guang-hua, ZHAO Wei, *et al.* Concave microlens arrays produced by femto-second laser with HF acid etching[J]. Acta Photonica Sinica, 2009, 38(3): 547-550. 李明,程光华,赵卫,等.飞秒激光和酸刻蚀方法制作凹面微透镜阵列[J].光子学报,2009,38(3):547-550.

[11] HATEM D, WOLFGANG H. Fast electronic and thermal processes in femto-second laser ablation of Au [J].Applied Physics Letters, 2006, 89(10): 104102(3).

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1. 左超,陈钱,顾国华.基于焦平面归一化响应特性的红外非均匀性校正[J].光子学报, 2011,40(6): 926-932
2. 匡登峰 方志良 杨勇 .原子力显微镜加工红外微透镜阵列的研究[J].光子学报, 2007,36(4): 659-662
3. 李庆;刘上乾;王炳健;赖睿.基于维纳滤波的红外焦平面阵列非均匀性校正算法[J].光子学报, 2006,35(12): 1908-1911
4. 徐田华;马彩文;赵亦工.基于四阶累计量的固定噪音参量估计[J].光子学报, 2006,35(5): 717-719
5. 李庆;刘上乾;赖睿;王炳健.一种基于场景的红外焦平面阵列非均匀性校正算法[J].光子学报, 2006,35(5): 720-723
6. 徐田华;赵亦工.基于递推最小二乘的红外焦平面非均匀校正算法[J].光子学报, 2006,35(2): 261-264
7. 周金梅;邢廷文;林妮媚.红外焦平面阵列非均匀性校正的精度分析[J].光子学报, 2005,34(11): 1681-1684
8. 拜丽萍;殷世民;刘上乾.一种新的基于场景的红外焦平面阵列非均匀性校正算法[J].光子学报, 2004,33(1): 109-112
9. 代少升;袁祥辉.基于DSP的红外焦平面阵列非均匀性实时压缩校正研究[J].光子学报, 2004,33(4): 469-471
10. 周慧鑫;殷世民;刘上乾;赖睿.红外焦平面器件盲元检测及补偿算法[J].光子学报, 2004,33(5): 598-600
11. 殷世民 相里斌 周锦松 黄旻.辐射源定标红外焦平面阵列非均匀性校正算法研究[J].光子学报, 2008,37(5): 992-995
12. 白俊奇 陈钱.基于局部梯度特征的红外微扫描成像技术研究[J].光子学报, 2008,37(11): 2253-2256
13. 张峰,刘上乾,汪大宝.一种新的基于平稳小波变换的红外焦平面非均匀性校正技术[J].光子学报, 2009,38(8): 2135-2138
14. 刘永进 朱红 赵亦工.基于帧间预测的红外焦平面阵列非均匀校正算法 [J].光子学报, 2009,38(4): 997-1000
15. 王娴雅,陈钱,顾国华,白俊奇.基于BP神经网络的红外焦平面非均匀性校正技术[J].光子学报, 2009,38(6): 1504-1506

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