Optics Communications 386 (2017) 14–21

Contents lists available at ScienceDirect

Optics Communications

journal homepage: www.elsevier.com/locate/optcom

Design and property study of micro-slot optics

Yuting Wang[a,b], Futing Yi[a,*], Tianchong Zhang[a], Jing Liu[a], Bo Wang[a], Yue Zhou[a,b]

[a] Beijing Synchrotron Radiation Facility, Institute of High Energy Physics, Beijing 100049, China
[b] University of Chinese Academy of Sciences, Beijing 100049, China

ARTICLE INFO

Keywords:
Micro-slot optics
LIGA
Ray tracing

ABSTRACT

LIGA (Lithographie Galvanoformung Abformung) as a very useful technique for fabricating devices with micro-scale structures has been reported to make the micro-pore optics (MPO) for years. Light weight is one of the advantages of MPO, making it an alternative for X-ray focusing lenses used on space telescopes. However, researchers seldom considered using the MPO in visible light region. In this article, we designed a micro-slot optics (MSO) similar to MPO and fabricated it by X-ray LIGA technique. The MSO consists of 159 concentric hollow cylinders of nickel with the slot spacings ranging from 59 to 113 μm and the focusing property of MSO is studied by simulations and experiments. Both the simulation and experiment results indicate that MSO is a useful focusing element. The MSO has one focal point when the point source is on the principal optical axis with the size of the focal point equaling to the size of the point source.

1. Introduction

In recent years, MPO has attracted much attention due to its advantages, such as small size and light weight. MPO can focus X-ray by reflection of its side walls and has successfully been applied as an X-ray imaging lens on space telescopes [1–3].

An MPO plate consists of millions of square through-holes in micro-scale arranged in a well-defined order. The sidewalls of these micro-pores with very small roughness can be used as grazing-incidence mirrors to reflect X-ray for imaging [4]. Researchers have already found that when a point source irradiates the MPO, most part of the light that is reflected twice by two adjacent sidewalls of the square pores can be focused on a center point on the principal optical axis. Other part of the light that is reflected only once by vertical or horizontal sidewalls can be focused on a cross. The crossover point is exactly the same center point mentioned above, in the focal plane of the MPO. The rest of the light that may be reflected more than twice or just irradiate through the holes of the MPO without being reflected become the background noise in the focal plane [5–7]. There are two different ways of fabricating MPO samples. One is to use drawing and stacking process on square glass fibers to obtain glass MPO [8]. The other one is to employ X-ray LIGA technique, which may provide square pores with

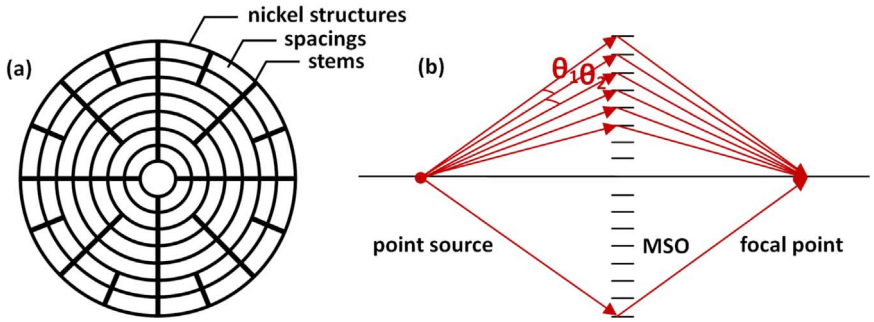

Fig. 1. (a) The sketch of the MSO. (b) The optical imaging diagram of the MSO in sectional view.

* Corresponding author.
E-mail address: yift@ihep.ac.cn (F. Yi).

http://dx.doi.org/10.1016/j.optcom.2016.11.020
Received 6 June 2016; Received in revised form 9 November 2016; Accepted 11 November 2016
Available online 15 November 2016
0030-4018/

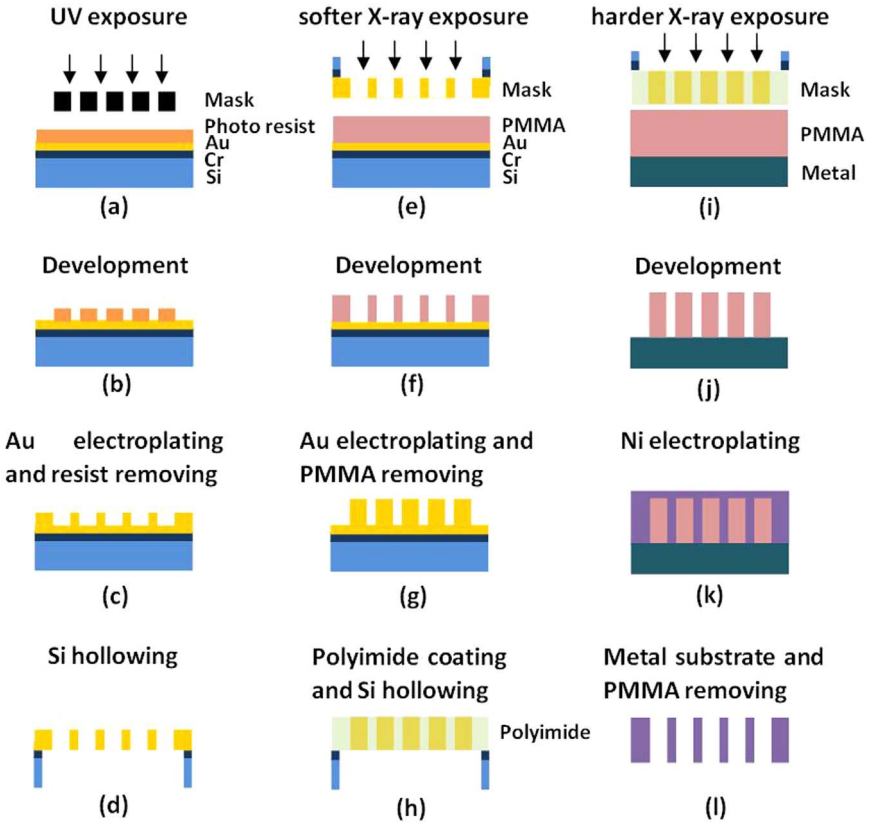

Fig. 2. The typical process of fabricate a Ni MSO using X-ray LIGA technique.

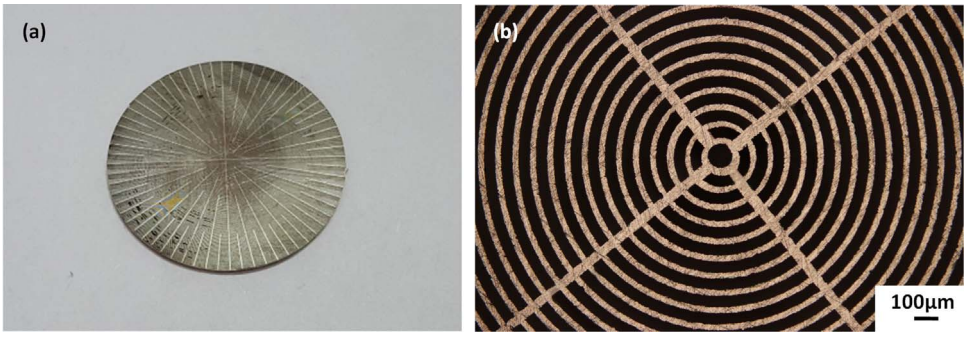

Fig. 3. (a) The final MSO. (b) The nickel MSO under microscope.

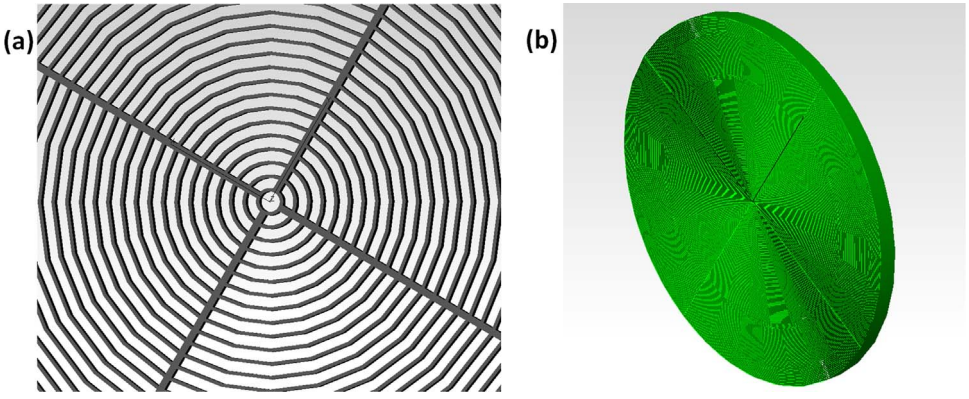

Fig. 4. (a) The center part of the MSO structure in TracePro. (b) The whole MSO in TracePro.