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EFFICIENT FABRICATION METHOD OF METALLIC NANO/MICRO STRUCTURES FOR NANO DEVICES

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ABSTRACT
A new effecient fabrication method of various nano/micro metallic structures for various optical nano devices is propsed in this paper. It is combination of nano chemical stamping, metal film deposition and selective peeling with glue. Characteristics of each step was studied experimentally using a line&space structured nano mold. It was shown that chemical stamping was useful for selective removal of coated metal film. Various nano/micro structures were successfully fabricated on quartz glass substrates, and feasibility of the proposed process was velified.

***Keywords*:** nano/micro fabrication, minute metallic structure, hot press, chemical stamp, peeling.

INTRODUCTION

It is known that metallic nano/micro structures on an optical substrate, such as a nano-dot array and a nano line array, exhibit unique optical characteristics attributed to LSPR (localized surface plasmon resonance), and they are expected to be applied in various bio sensors [1-2] and nano optical-electronical devices [3-4]. Since LSPR property depends on the size, shape and alignment of the metallic structures, manufacturing technologies with good accuracy and high productivity are demanded. In this paper, a new fabrication process of metallic nano/micro structures is proposed which consists of combination of chemical stamping, metal film deposition and peeling technique to achieve high productivity and low cost production. Objective of this paper is to study characteristics of each process steps, and to verify feasibility of the process for efficient fabrication of metallic nano/micro structures for optical nano devices.

RESULTS AND CONCLUSIONS

Figure 1 illustrates the nano/micro fabrications process newly proposed in this paper. It comprises of four steps. (1) A polymer film mold of nano/micro structures is made by duplicating a silicon mother mold by hot embossing method. (2) Liquid chemical is dropped on the polymer film mold, and the film mold is pressed on a quartz glass substrate that is cleaned by Ar sputter etching preliminary. (3) After the substrate is dried in air, Au is deposited on the substrate by using a DC sputter coater. Then, PVAc (polyvinyl acetate) is coated on the Au layer. (4) After curing of PVAc, the PVAc layer is peeled off from the

substrate manually. Due to degrade of bonding strength between the Au layer and the substrate by the stamped acetone, the Au layer on the acetone stamp is peeled off with the PVAc layer. Finally, an Au nano/micro structure remains on the glass substrate.

Figure 2 shows an example of AFM image and the surface profile of the polymer film mold produced by the hot embossing method. It is confirmed that a uniform line&space structure with crests of 2 μm in width and grooves of 1 μm in width was fabricated.

Figure 3 shows an AFM image and surface profile of Au nanowires fabricated on a glass substrate after peeling operation. It is apparent that Au layer on the stamped acetone bands were removed by peeling the PVAc layer off. It was found that average thickness of nanowires was about 10 nm and the average width of nanowires was about 1 μm. Width of the nanowires agrees with the grooves of the polymer mold. It was verified that chemical stamping was useful for selective removal of coated metal layer in nano/micro size. In addition, various metallic nano/micro structures were fabricated by the proposed method, and feasibility of the process was verified.

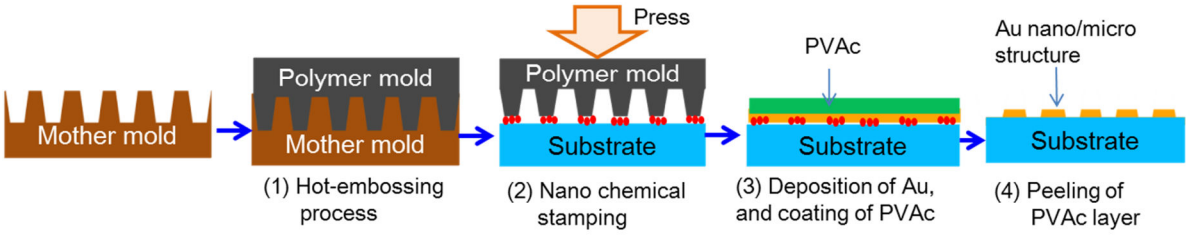

Fig. 1 - Illustration of proposed nano/micro fabrication process.

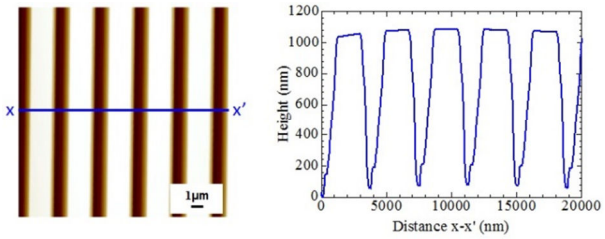

Fig. 2 - AFM image and surface profile of a polymer film mold.

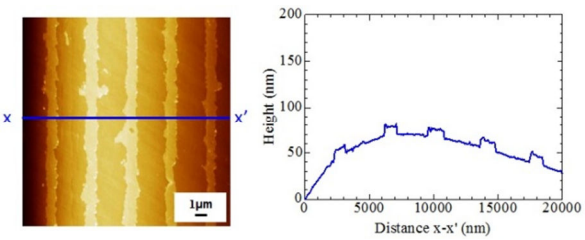

Fig. 3 - AFM image and surface profile of gold nanowires fabricated with a glass substrate.

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