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Nanofabrication of DLC-dot Arrays by Room-temperature Curing Imprint-liftoff Method

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ABSTRACT

As an application to the nanoemitter, we investigated the nanofabrication of diamond-like carbon (DLC)-dot arrays by room-temperature curing imprint-liftoff (RTCIL) method using aluminum mask. The DLC film which has excellent properties similar to diamond properties was used as the patterning material. A polished glass like carbon (GC) was used as a mold material. The polysiloxane in the state of sticky liquid at room temperature and stable in air exhibits a negative-exposure characteristics. Therefore, the polysiloxane was used as electron beam (EB) resist and oxide mask material in EB lithography, and also used as RTC-imprint resist material. An aluminum was used as oxide metal mask material of liftoff. We have fabricated the GC mold of dot arrays with 5 μm-square and 500 nm-height. We carried out the RTCIL process using the GC mold under the following optimum imprint conditions: 0.5 MPa-imprinting pressure and 5 min- holding time. Aluminum film on the imprinted polysiloxane was prepared by vacuum evaporation method and its thickness is 20 nm. Finally, the polysiloxane patterns were removed with acetone and aluminum mask patterns were fabricated. We found that the maximum etching selectivity of aluminum film against DLC film was as high as 35, which was obtained under an ion energy of 400 eV. Then we processed the patterned aluminum on DLC film with an ECR oxygen ion shower. We fabricated DLC-dot arrays with 5 μm-square and 400 nm-height with an aspect ratio of 0.08.

INTRODUCTION

The DLC (diamond-like carbon) exhibits unique electrical, mechanical, thermal, optical and chemical properties such as low dielectric constant, high hardness, low coefficient of friction and high transmission, and so it is expected to have various applications. For example, it can be used as nanoemitter for plasma display panel [1], micro-gear for MEMS (Micro Electronic Mechanical Systems) [2], micro-lens array for optical device [3] and blu-ray for generation patterned media [4]. Therefore, the nanopatterning technique for a diamond is essential to the fabrication of functional diamond micro- and nano-devices.

The room-temperature curing nanoimprint lithography (RTC-NIL) using polysiloxane that we developed has certain advantages, including shorter steps, higher throughput and lower cost than those of conventional thermal-cycle NIL [5]. We have already investigated the