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Fabrication of Diamond Nanopit arrays by Room-temperature Curing Nanoimprint Lithography Using Glass-like Carbon Molds

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ABSTRACT

We have proposed the use of glass-like carbon (GC), as mold material because the 27-maximum etching selectivity of polysiloxane film against GC, which was approximately six times larger than that of polysiloxane film against chemical vapor deposited (CVD) diamond film. We have investigated the fabrication of diamond nanopit arrays by room-temperature curing nanoimprint lithography (RTC-NIL) using GC mold, as applications to the emitter and the micro-gear. The polysiloxane has in the state of sticky liquid at room-temperature and negative-exposure characteristic. Therefore, the polysiloxane was used as RTC-imprint resist material, and also used as electron beam (EB) resist (oxide mask) material in EB lithography. We have fabricated the cylindrical GC nanodot mold with 500 nm-diameter, 600 nm-height and 2 μm-pitch. We carried out RTC-NIL using GC mold under the following optimum conditions: time from spin-coating to imprint of 1 min, imprinting pressure of 0.5 MPa and imprinting time of 5 min. Then, we have processed the diamond film with an electron cyclotron resonance (ECR) oxygen ion shower. We have fabricated diamond nanopit array with 250 nm-depth and 500 nm-diameter. The diameter of diamond nanopit pattern was in good agreement with that of GC mold. Moreover, the depth of the diamond nanopit patterns fabricated by RTC-NIL using cylindrical GC mold was three times larger than that using conical diamond mold.

INTRODUCTION

The diamond exhibits unique properties such as high hardness, high thermal conductivity, wide band-gap and chemical stability, and so it is expected to have various applications. For example, it can be used emitter for flat panel display [1], micro-gear for medical MEMS (Micro Electronic Mechanical Systems) [2, 3], micro-lens array for optical device [4, 5] and blue-ray for storage media [6]. Therefore, the nanopatterning technique for a diamond is essential to the fabrication of functional micro/nano-devices. We had already investigated the nanopatterning of chemical vapor deposited (CVD) diamond film in room-temperature curing nanoimprint lithography (RTC-NIL) process, using diamond mold [7]. The RTC-NIL using polysiloxane that we developed has certain advantages, including short steps, high throughput and low cost. The diamond mold had been fabricated with electron cyclotron resonance (ECR) oxygen ion shower