Improving the Pore-channel Uniformity through Back-side Treatment of Anodic Aluminum Oxide

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In this research, we fabricated an array of nanometer-scale channels by using porous anodic aluminum oxide with the bottom barrier layer removed to open up the pores on both ends. However, the aluminum and oxide layers remaining underneath affect the removal of the barrier, leading to a locally-uneven etching process and a nonuniform pore-size distribution across the sample's surface. To increase the pore-channel uniformity, we removed the oxide layer at the bottom separately and compared the pore-channel structures with and without the bottom oxide removed. We observed that when this removal process was applied, the channel arrays that formed at both the center and the edge of the sample had more uniform dimensions than those prepared without this additional back-side treatment.

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I. INTRODUCTION

When an aluminum surface is anodized under appropriate condition, the formation of nanometer-scale pores occurs [1]. These pores are well-ordered and their dimensions such as pore diameter and spacing between the pores can be easily controlled by the type of the electrolyte used during the anodization process as well as the anodization voltage and duration. The structural parameters exhibited by these pores on the surface of the anodic aluminum oxide (AAO) are typically ranging from ten to a few hundred nanometers, enough to look into physics at small scale and to allow simple nanopatterning process. The porous nature of AAO has helped to understand electron transport in nanostructured superconducting and metallic films [2, 3], and realize ferroelectric and magnetic nanodot and antidot arrays [4, 5].

In these, one of the key factors utilizing AAO is the presence of the uniform pores covering large area. However, during the subsequent fabrication processes such as repeated etching and removing steps, following the two-step anodization, it becomes hard to maintain the pore uniformity across the sample area. This might lead to locally varying physical characteristics at the center and the edges along the nanodot and antidot arrays, which prevents from fully exploiting the advantage of using AAO-based fabrication over the conventional methods.

Here, we have fabricated a pore-channel structure by removing and opening-up the barrier layer underneath AAO, which can be used to prepare a nanodot array via simple physical deposition method. Especially, we have applied the additional back-side treatment during the fabrication step, resulting in the much improved pore-channel uniformity across the sample area when compared to the structure prepared without this back-side treatment.

II. EXPERIMENTS

The porous AAO was fabricated via two-step anodization technique. Prior to the anodization, thin Al foil was mechanically and electrochemically polished. The first