Regular Paper

Preparation of CNx Films by RF Reactive Sputtering – Effects of Sputtering Gas on the Hardness and Friction Coefficient –

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Abstract

Amorphous carbon nitride CNx has excellent mechanical properties such as high hardness and a low friction coefficient, especially in a nitrogen gas atmosphere. Therefore, we investigated sputtering gas effects on the film structure and mechanical properties for the preparation of CNx films by RF reactive sputtering. The CNx films were prepared using RF magnetron sputtering apparatus. Graphite was used as a target. Ar and N_2 were used as sputtering gases. Their ratios were Ar/N_2=1/0, 1/1, 1/3, and 1/5. The substrate electrical potential was selected as grounded or floating. The CNx film deposition rates were increased by adding nitrogen gas to Ar using the floating substrate holder. However, the hardness was decreased by adding nitrogen gas to Ar. The nitrogen contents increased slightly up to 25% with the increase of nitrogen gas added to the sputtering gases.

Keywords: CNx, reactive sputtering, nano-indentation

1. Introduction

Amorphous carbon nitride CNx, which is nitrogen-containing diamond-like carbon (DLC), has excellent mechanical properties such as high hardness and a very low friction coefficient in a nitrogen gas atmosphere[1)]. Actually, CNx has an extremely wide variety of structures and physical properties[2)]. Moreover, the properties of these materials can be improved by controlling the nitrogen amounts[3)]. In addition, CNx can be deposited to various substrate materials using thin film deposition processes such as physical vapor deposition (PVD)[4)] and chemical vapor deposition (CVD)[5)]. These materials are anticipated for application to a wide range of industrial products[6)]. Reactive sputtering can prepare compounds such as oxide and nitride by addition of O_2 and N_2 as a reactive gas during sputtering[7)] and it is easy to control the amounts of elements in the film[8)]. Effects of reactive gas compositions for reactive sputtering processes were reported influence significantly on the film structure and mechanical properties of the films. However, only few reports for CNx system was reported. Therefore, this investigation was carried out for the effects of sputtering gas on the film structure and mechanical properties for the preparation of CNx films by RF reactive sputtering.

2. Experimental method

First, CNx films were prepared using a RF magnetron sputtering apparatus. Fig. 1 presents the schematic illustration of RF magnetron sputtering apparatus.

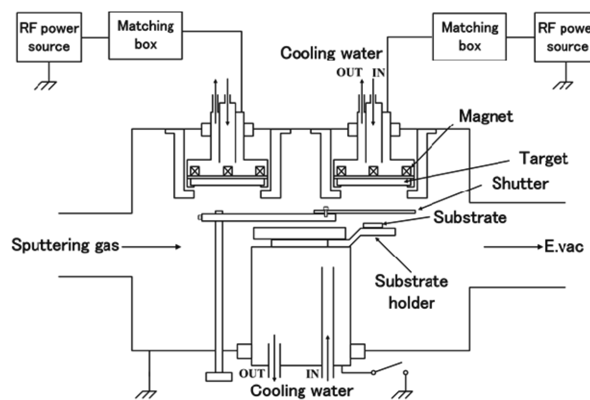

Fig. 1 Schematic illustration of the RF magnetron sputtering apparatus.

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