14th International Conference on Plasma Based Ion Implantation & Deposition

PBII&D 2017

New World Shanghai Hotel

October 17-20, 2017, Shanghai, China

Program

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ID 108

Simulation Study of the magnetron sputtering: from discharge to Target Etching by PIC/MCC method

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Keywords: PIC/MCC method, magnetron sputtering, discharge, target etching

Abstract: In order to obtain high target utilization and reduce deposition cost in magnetron sputtering, target surface etching depending on various cathode structure and magnetron distribution should be researched to achieve more uniform etching on the whole target surface. Many methods have been developed to study the target etching before [1-2], however, all the researches are originated from magnetic distribution without considering the evolution of the discharge plasma, which results in an inaccurate simulation. The PIC/MCC method is reported to be the most accurate way to study the plasma distribution and evolution despite the low computational speed [3-4]. This paper proposes a new PIC/MCC method for the simulation of the discharge and the induced target etching, and the results are used to guide the cathode design.

Cu is used as target material in the simulation, thus when sputtering stabilized, the discharge plasma is dominant by Cu ions, Ar ions are ignored. The ion movement is simulated by PIC/MCC method with a two-dimension model. The number of Cu-ions which hit on the target as counted in each Δt, inducing target etching proportionally. The angle of incidence and the ion energy are taken into consideration in the simulations.

The magnetic field distribution is optimized by the simulation and the results are shown in Fig. 1. The discharge and the plasma evolutions are calculated by PIC/MCC method and the etching of the right side of the target is shown in Fig. 2. Each line is the target shape of the etching runway at the corresponding moment, revealing a homogeneous target etching. The experiment result shown in Fig. 3 demonstrates the same result with the simulation.

A new simulation method based on PIC/MCC is developed to study the target etching starting from the discharge and the plasma evolutions in magnetron sputtering, which can obtain more accurate results according to the experimental etching.

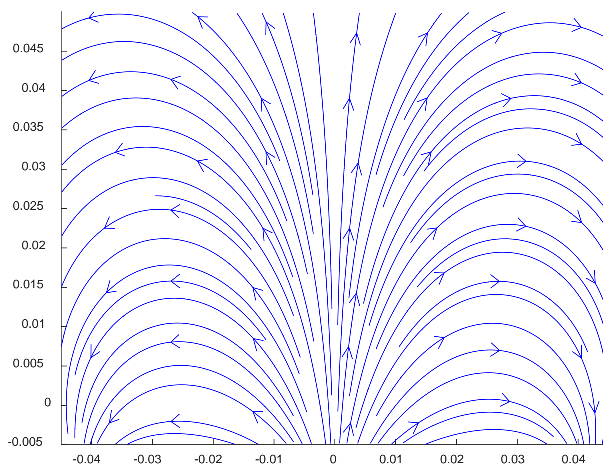

Figure 1 An optimized magnetic field distribution on the target surface

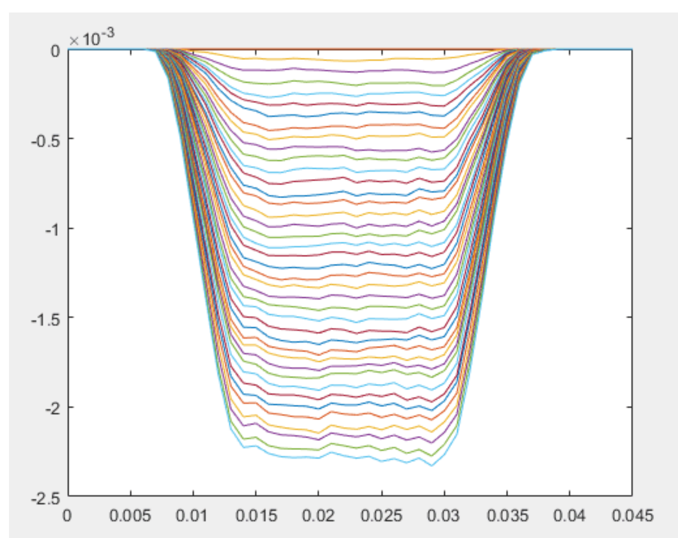

Figure 2 The simulation results of the planar target etching

Figure 3 The Etching ring on the target surface

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