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Author: Dr. Yifan Wang
Tsinghua University, China

Dr. Hao Liu
Tsinghua University, China
Prof. Ge Dong
Tsinghua University, China

PRESSURE DISTRIBUTION OF GAS MOLECULES IN THE WAKE AREA OF A FOLDABLE WING-TYPE ORBITAL MOLECULAR SCREEN

Abstract

Molecular beam epitaxy (MBE) has been used by many research institutes and electronics companies around the world to produce semiconductor micro-nano heterostructures, and is widely considered to be one of the most promising processes for obtaining semiconductor structures. MBE technology has extremely high requirements on the cleanliness and vacuum of the production environment. Compared with the earth, the space has the natural environmental advantages of low pressure and microgravity. The production of advanced thin-film materials through MBE technology in low-Earth orbit has obvious advantages. However, the environmental pressure in low-Earth orbit itself cannot truly meet the environmental vacuum requirements during the production of thin film materials using the MBE technology. It is still necessary to use molecular screens to generate ultra-high vacuum areas in which to complete the production of thin film materials. This paper uses the direct Monte-Carlo method (DSMC) to numerically simulate the number density distribution of different gas components and the resulting pressure distribution in the wake area of a flat-plate molecular screen. The calculation results show that the main components of the gas in the wake area are hydrogen atoms and helium atoms, and the pressure in the wake area is mainly generated by hydrogen atoms. Without considering the outgassing of the material, the pressure in the wake area can reach as low as 10^{-12} Pa. The ultra-high vacuum area in the wake area can meet the needs of the MBE technology production. In addition, this paper also simulates the gas component density and pressure distribution in the wake area of a new type of foldable wing molecular screen, and compares the results with the results in the wake area of the flat-plate molecular screen. The results show that compared with the flat-type molecular screen, the foldable wing molecular screen can obtain lower pressure in the wake area under the condition of appropriate wing length and wing angle, and the low-pressure working area is also expanded. In short, it is feasible to use molecular screens in low-Earth orbit to obtain an ultra-high vacuum environment that meets the needs of the MBE technology for production. In the future, it is planned to conduct experiments on the pressure in the wake zone of flat-plate and foldable-wing molecular screens on the Chinese Space Station, and compare with the calculated results.