22nd IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Innovative Concepts and Technologies (1)

Author: Dr. Hao Liu
Tsinghua University, China

Dr. Yifan Wang
Tsinghua University, China
Mr. hai bin Meng
China
Mr. Yongkang Liu
Tsinghua University, China
Dr. Pengfei Ji
Tsinghua University, Beijing, China
Prof. Ge Dong
Tsinghua University, China

MADE IN SPACE - MANUFACTURE OF SEMICONDUCTOR THIN FILMS IN SPACE BY MOLECULAR BEAM EPITAXY TECHNOLOGY

Abstract

Over nearly six decades, advancements in astronautical technology, spurred notably by Space X, have revolutionized near-Earth and deep space exploration, driving down transport costs and catalyzing the migration of terrestrial technologies to space. This paper elucidates the technological realization of a space-based semiconductor factory employing Molecular Beam Epitaxy (MBE) technology, facilitated by a round-trip transport system between Earth and space. By harnessing MBE technology's precision and yield advantages, semiconductor production in space achieves unparalleled quality and efficiency compared to terrestrial methods. While MBE technology holds promise for industrial production, its terrestrial applications are constrained by limited capacity and suboptimal product quality. To address these issues, this project proposes the enhancement of ground-based MBE equipment for space operation, situated approximately 350km above Earth's surface. Through a detailed analysis of prior research and testing, the feasibility and necessity of space-based MBE processes are underscored, fostering novel avenues for space manufacturing and advancing MBE technology. Key to the implementation of space-based MBE processes is the introduction of the molecular screen, a crucial device enabling MBE process environments in space. This device maintains the ultra-high vacuum at the level of 10^{-12} Torr, which is essential for MBE operations at the designated altitude of 350 km. Additionally, future test programs and application scenarios are proposed based on the latest molecular screen structural design. Furthermore, the article examines the indispensable role of a round-trip transport system between Earth and space in facilitating the logistical operations of a space factory. Drawing from historical experiences, optimized flight system designs are proposed to support the efficient and economical transit of raw materials and finished products. In conclusion, this article highlights the significant economic and social benefits of space factories, particularly in revolutionizing microelectronics and semiconductor industries. With an emphasis on the urgency of space factory projects amidst the trend towards cost-effective space transport systems, this paper underscores the transformative potential of space-based semiconductor manufacturing in driving innovation and economic growth in high-tech industries.