PLASMA LABORATORY

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Introduction

The Plasma Laboratory was funded by the Hong Kong Research Grants Council, City University of Hong Kong. Hong Kong University of Science & Technology, and the Hong Kong University. Construction of the laboratory and class 1000 cleanroom was completed in 1996.

Plasma Immersion Ion Implantation (PIII) is a versatile technique to synthesize thin films and modify the surface properties of materials and industrial components. Unlike conventional beam-line ion implantation, PIII excels in the processing of large and irregular specimens. The instrumentation is relatively simple and cost effective. This burgeoning technology has found many applications from the enhancement of aerospace and industrial components to the fabrication of new materials used in the microelectronics industry.

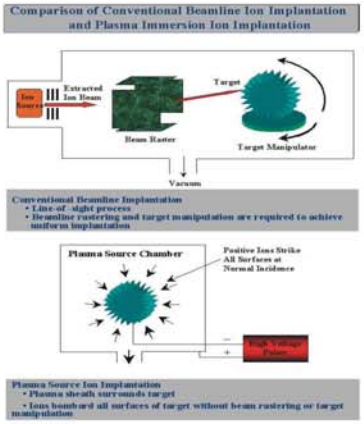


Fig 1. Class-1000 cleanroom housing the multi-purpose plasma immersion ion implanter in the foreground and semiconductor PIII machine in the background.

Major Equipment

* Class-1000 cleanroom
* Multi-purpose plasma immersion ion implanter
* Semiconductor plasma immersion ion implnter
* Annealing equipment
* Infrared inspection and wafer bonding setup
* Sample preparation equipment
* Simulation computers and workstations

Research Projects

(A) Surface Modification

In addition to research projects on metallurgy and tribology, there are collaborative programs with the Chinese Ministry of Aerospace and Chinese Department of Nuclear Energy to improve the properties of critial and strategic components. There are two programs on biomedical engineering, one with the Research Center, Rossendorf in Germany on enhancing the durabiltiy of articial teeth and the x-ray contrast of blood vessel stents and the other one with Southwest Jiaotong University in China to improve the biocompativiliy of artificial hearts. Our research group is also working with scientists form Lawrence Berkelty Laboratory (US), Cambridge University (UK), Beijing Normal University (China), and Dalian University of Science and Technology (China) on metal ion implantation and instrumentation. One of the research projects of the Plasma Laboratory was rated

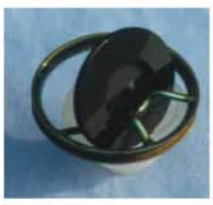


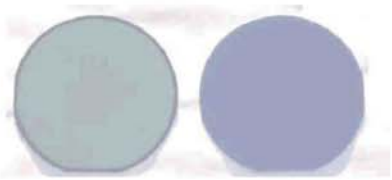
Fig. 2. Artificial heart valve treated by PIII in the Plasma Laboratory.

Fig. 3. PIII treatment of the races of the inner and outer rings of a satellite ball bearing.

Fig. 4. PIII Treatment of blood vessel stents to improve x-ray

(B) Semiconductor Processing

Current programs focus on silicon-on-insulator (SOI), low dielectric constant (k) materials for integrated circuits, light emitting materials, microcavity engineering, thin film engineering, and plasma doping. The programs are sponsored by the City University of Hong Kong, Hong Kong Research Grants Council, Silicon Genesis Corporation (US), and Komatsu Electronic Metal (Japan). Active research collaborators include Matsushita / Panasonic (Japan). University of California at Berkeley (US), University of California at San Diego (US), Northeastern University (US), Hong Kong University of Science and Technology, Hong Kong University, Fudan University (China), Peking University (China),



SOI Wafer Donor Wafer

Fig. 5. SOI wafer (left) produced by PIII in the Plasma Laboratory of the City University of Hong Kong and bonding / ion-cut at Silicon Genesis Corporation (Courtesy of Silicon Genesis Corporation, California, USA)

Fig. 6. An aluminum plasma shower head treated by nitrogen PIII at elevated temperature (500 degree) is shown in the left picture with a 12-inch ruler and the PIII equipment in the background. The right photograph depicts a treated (left) and untreated (right) shower head. PIII is ideal for large sample possessing irregular geometry such as these plasma shower heads. Nitrogen PIII improves the surface properties and mitigates particle formation.

(C) Plasma Physics and Process Modeling

Extensive simulation and modeling work is being conducted to understand the physics and chemistry of PIII. Our research group members are using two-and three- dimensional fluid and particle-in-cell (PIC) models to investigate various instrumental issues, implantation parameters, as well as implantation into irregular targets. The programs are funded by the City University of Hong Kong and Hong Kong Research Grants Council. Researchers of Plasma Laboratory are currently collaborating with the Australian National University (Australia), Lawrence Berkeley Laboratory (US), University of California at Berkeley (US), University of Michigan (US), and Los Alamos National Laboratory (US).

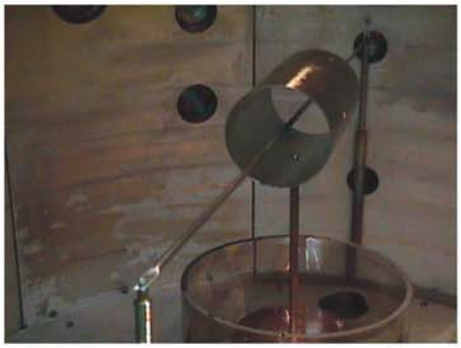


Fig. 7. PIII into the interior surface of a cylindrical bore using an auxiliary electrode.