MERIT-WINGS インターンシップ（国内）報告書

Report for MERIT-WINGS internship (domestic)

工学系研究科 電気系工学専攻
博士課程 1 年 MERIT 11 期生
YU Baisen

1. インターンシップ概要 (Basic Information of Internship)

- 実施期間
  2023 年 2 月 1 日から 2023 年 2 月 28 日(1 ヶ月間)
- 受入れ先
  東京エレクトロン テクノロジーソリューションズ株式会社 シミュレーション技術開発部
- 研究テーマ
  半導体製造装置内の内部流動の数値シミュレーション
- 住所
  〒407-0192 山梨県韮崎市穂坂町三ツ沢 650

2. 研究背景 (Research background)

For most of semiconductor thin film equipment, e.g. Inductively Coupled Plasma (ICP), Chemical Vapor Deposition (CVD), Atomic Layer Deposition (ALD), etc., flowing various gases into a chamber is a necessary and important step to trigger specific chemical reactions and realize targeted functions. To improve the performance of such kind of semiconductor equipment, it is very crucial to study the distribution and the time-dependent characteristics of the flowing gases in a chamber, because the behavior of gases determines the final quality of a processed thin film. However, gas itself is invisible in most cases and commonly used detecting equipment like vacuum gauge can only detect the pressure at a fixed point, which make experimental investigation of gas flowing difficult and time-consuming. Therefore, simulating the gas flowing by Computational Fluid Dynamics (CFD) is a more feasible and effective way. First, simulation can offer us a pre-assessment on a designed structure before it is manufactured. Additionally, changing parameters in a simulation is much easier and efficient, which saves us a lot of time for finding optimized designed parameters of an equipment.

In this internship, I was trained to acquire the basic skills of conducting CFD calculations based on a commercial software, ANASY Fluent, and understand the basic physics and behavior of gas flowing in semiconductor thin film chambers. Additionally, I have also learned to use some other software to edit 3-D chamber geometries and visualize the simulation results by generating animations. At the end of the internship, I analyzed the oxidization reaction step in an Atomic Layer Deposition (ALD) chamber, and optimized the parameters to finish the reaction with high uniformity and shorter time.

3. 研究内容 (Research contents)

Since my research field at university is different from what I am going to do in the company, learning some physical basis about Dynamics of Fluid is necessary. The company offered me many lectures as an overall introduction including the equations for describing the movement of a fluid, the basic criteria for selecting appropriate models, the judgement of the correctness of calculation results and so on. After that, I was trained to use a few software as practice. The software, SpaceClaim, is used for editing the geometry of a chamber in three dimensions. For example, a provided geometry by customers may be very complicated, because many other structures without gas flowing is included. In such case, we have to make some simplifications and extract the parts flowing gases from the whole structure by SpaceClaim. The geometry edited by SpaceClaim will be loaded into the software, ANASY Fluent, where discretization of the geometry is conducted and the corresponding meshes are formed for the numerical calculations, as shown in the Figure. 1(a). Then, by selecting appropriate calculation models and boundary conditions, one can start the iterative calculation in ANASY Fluent until a certain convergence criterion is met. Sometimes, calculation tasks are very heavy, but a remoted server is helpful to get results faster. In my department, a Unix-based server with more than 400 cores can be used for ANASY Fluent-based calculations. And I learned the basic systematical structure of a remoted serve and how to use it to automate calculation tasks. Finally, there is a specialized software, EnSight, to post process the calculation data and generate animations for better visualizing the results.

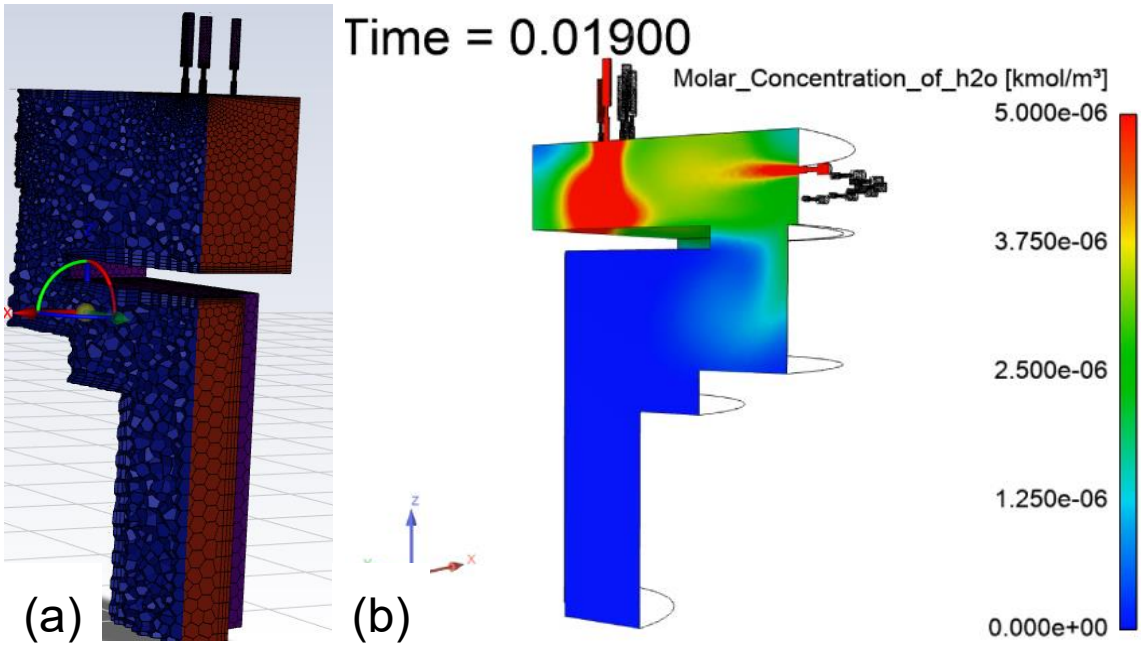

Figure. 1. (a) An example of discretized geometry. The structure is fulfilled by a great number of volume meshes. (b) The distribution of H_2O at a specific time in an ALD chamber.

After acquiring basic skills of the software above, I was assigned a specific task to analyze the oxidization reaction step in an ALD chamber and check the uniformity and speed of the

formed thin film. By adjusting many parameters, I found a better design to achieve a uniform thin film with short time. Figure. 1(b) shows an example, which is the distribution of H_2O in an ALD chamber at 0.019 sec.

4. 所感 (Impressions)

In this one-month internship, I acquired basic knowledge and skills about the theories and implements of Computational Fluid Dynamics (CFD). I was impressed by the highly efficient and useful roles that the simulation technology plays in the improvement of semiconductor thin film products. Also, I realized that how difficult to design and manufacture high-performance semiconductor equipment, which requires well cooperation of numerous experts from various fields. More important for me, it is the first time that I have a working experience in a company and learn about how people do the research in different environment, which makes me deeply think of my future career plans.

5. 謝辞 (Acknowledgements)

First, I would like to thank MPCoMS マッチングプログラム for providing this internship opportunity with me. The staffs in MPCoMS helped me connect with the company and kindly gave me many suggestions. Then, I would like to thank the members in Tokyo Electron company for offering this internship to me and teaching me a lot of techniques about the usage of software. It is a wonderful one-month internship and I have benefited a lot from this valuable experience. Third, I would like to thank MERIT-WINGS program for the approval of this internship. Finally, I would like to thank my supervisor, Prof. Tanaka, and MERIT associate supervisor, Prof. Takagi, for the support and agreement of this internship.