

Mechanical Engineering Education in Kochi University of Technology (KUT), Japan

Shahjada Ahmed Pahlovy*
Intelligent Mechanical System Engineering Department,
Kochi University of Technology, Japan

Sadao Momota
Intelligent Mechanical System Engineering Department
Kochi University of Technology, Japan

Yao Ying Xue
Mechanical Electronics Engineering Department,
Harbin Institute of Technology, Harbin-China.

096402c@gs.kochi-tech.ac.jp

Abstract

Mechanical Engineering covers the design, analysis, testing and manufacture of products that are useful in every aspect of modern society. The mechanical engineer not only can design a component only but also may design a machine, a system or a process. Mechanical engineers will examine their design using the principles of motion, energy, and force to insure the product functions safely, efficiently, reliably, and can be manufactured at an economic cost. In this present paper introduce current mechanical education called as Intelligent Mechanical System Engineering Department in Kochi University of Technology, its collaborations globally and locally, course and curriculum. Finally the facility, lab equipment with principle and their practical applications of Atomic and Nuclear Physics, Material Physics and Nano Manufacturing lab of KUT intelligent mechanical system engineering research groups are briefly described.

Introduction

Development of technology and subsequently setup new industries centered around that technology is important for contributing the growing of Japanese industry. By this assumption, workers in each industry should be able to identify and define the market related to new technology; this call for entrepreneurial experience and energy, primal to the foundation of a new organization or venture business that can realize technology commercially. In order to consider those factors KUT's graduate school provides the Entrepreneur Engineering Course, which has no equivalent or predecessor in the undergraduate school. This course is suitable for engineers who are working as leaders or instructors in business. Including global management theory and information courses, courses dealing with the relationship between modern technology and management for managers of technology and engineering enterprises etc. courses offered by KUT. There are several program is conducted solely on weekends. Students take part in virtual discussions and lectures in Tokyo and Osaka in addition to their activities on the KUT campus in Kochi.

Globally, Japan's role is to develop originative, pioneering technology and idea that can direct the world, and to incorporate them into new industries, which will open up new frontiers. For facing this challenge and for promoting the development of human resources that can place a dynamic role in the future society with a global perspective, KUT has established their Graduate School of Engineering.

Mechanical Engineering Research activity in KUT:

Worldwide economic challenge and rapid social change demand for new goods and originative enterprises based on original idea in the branch of mechanical engineering. Advance technological development needs an interdisciplinary scope that can solve the multitude of challenges of the unlimited information age, the graying of the population and environmental problems. In the Intelligent Mechanical Systems Engineering Courses, one can do the following research areas:

1. Both in fundamental mechanical engineering, robotics and mechatronics
2. Intelligent information technology

3. Advanced simulation technology
4. And human-related technology

The university prefers such research with new conceptions for both next-generation mechanical systems and ultra-mechanical technology. Its course is emerging as a training ground for leading professionals in intelligent mechanical engineering and related fields. In Fundamental mechanical engineering, robotics and mechatronics research area there are several labs for different types of research. In this paper briefly describes the Atomic and nuclear physics, Materials physics and nano-manufacturing lab, its lab equipment, working principle and recent research development.

Details of Atomic and Nuclear Physics, Material Physics and Nano Manufacturing lab

This lab equipped with several lab equipments. But the main lab equipments are:

1. Electron Cyclotron Resonance (ECR) Ion beam irradiation system.
2. Carbon Nano Tube (CNT)

Electron Cyclotron Resonance (ECR) Ion beam irradiation system

Hot-plasma ion sources or Electron Cyclotron Resonance (ECR) ion sources and their operation principal are schematically shown in Figure 1. During electrons movement in a magnetic field they gyrate around the magnetic field lines due to the Lorentz force. The gyration frequency is called the cyclotron frequency ω_{cyc} . If microwave radiation of the same frequency propagates into such a region, the electrons are resonantly accelerated or decelerated (depending on the phase of their transversal velocity component with respect to the electric field vector) when the electron cyclotron resonance condition is fulfilled:

$$\omega_{hf} = \omega_{cyc} = (e/m) \times B$$

Here, e and m denote the charge and mass of the electron, respectively. The plasma electrons are confined in a superposition of an axial magnetic field component (produced by solenoids or permanent magnets) and the radial magnetic field of a multipole magnet.

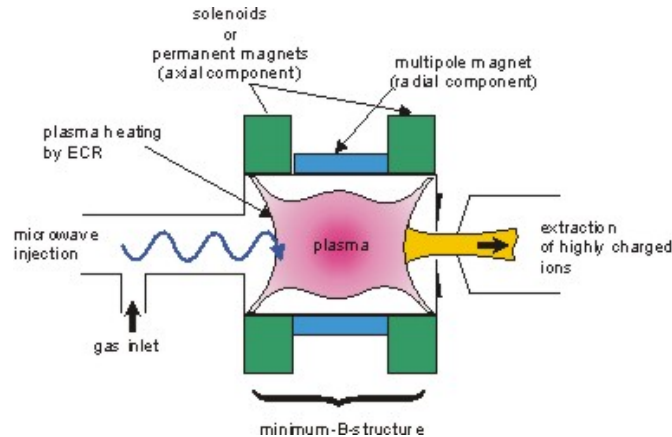


Figure 1: Operation principle of an ECR ion source

This result in a so-called minimum-B-structure because the magnetic field has a minimum in the middle of the structure and from there increases in all directions. Therefore, a closed surface is created where the electron cyclotron resonance condition is fulfilled. Electrons passing through that surface can be accelerated resonantly. Furthermore, a high mirror ratio of the magnetic field leads to long confinement times for the plasma electrons. They can pass the resonance region very often, gain high energies and ionize plasma atoms and ions into high charge states via successive single ionization. In Figure 2 the magnetic field of such a minimum-B-structure is show for a 14 GHz ECRIS. Figure 3 shows a simulation of an argon ion beam that was extracted from an ECR ion source with an acceleration voltage of 10 kV. The beam quality is determined by parameters like extraction voltage and geometry, intensity, magnetic field in the extraction region, etc. After the extraction the beam widens up because of its space charge. However, by using ion-optical elements it can be focused again and adapted to the following beam line.

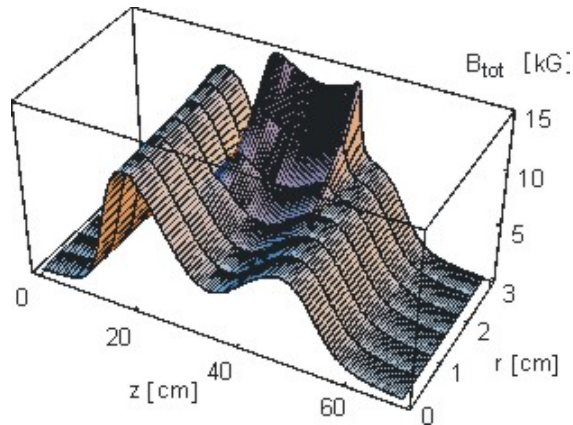


Figure 2: Magnetic field of a minimum-B-structure

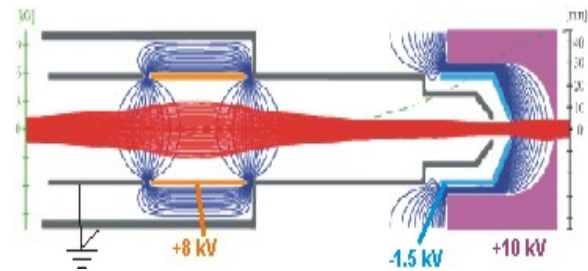


Figure 3: Simulation of an argon ion beam

The ions in the plasma are not accelerated due to their large mass and remain thermal. Therefore they are not confined by the magnetic field but by the space charge potential of the electrons.

This magnetic confinement, however, is not perfect and electrons can leave the plasma, for example in axial direction. Since the plasma tends to stay neutral, ions will follow the electrons. By using suitable extraction geometry and by applying high voltage the ions can be extracted from the ion source.

Fig 4 shows the current ECR irradiation system in KUT and fig 5 shows the fabrication of SOG by KUT ECR research group.



Figure 4: ECR ion irradiation system in KUT

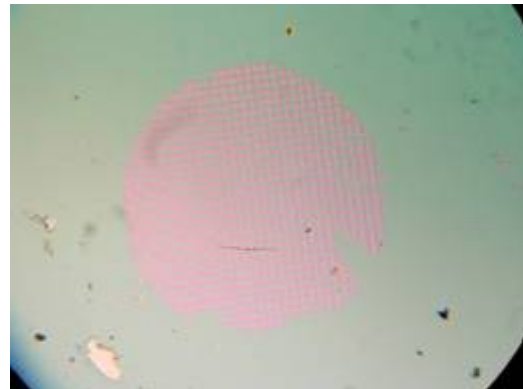


Figure 5: Fabrication of SOG by KUT ECR.

Carbon Nanotube Science and Technology

Discovery

Carbon nanotubes are fullerene-related structures that consist of graphene cylinders closed at either end with caps containing pentagonal rings. They were discovered in 1991 by the Japanese electron microscopist Sumio Iijima who was studying the material deposited on the cathode during the arc-evaporation synthesis of fullerenes. He found that the central core of the cathodic deposit contained a variety of closed graphitic structures including nanoparticles and nanotubes, of a type that had never previously been observed. A short time later, Thomas Ebbesen and Pulickel Ajayan, from Iijima's lab, showed how nanotubes could be produced in bulk quantities by varying the arc-evaporation conditions. This paved the way to an explosion of research into the physical and chemical properties of carbon nanotubes in laboratories all over the world.

Single-layer nanotubes and nanotube "ropes"

A major event in the development of carbon nanotubes was the synthesis in 1993 of single-layer nanotubes. The standard arc-evaporation method produces only multilayered tubes. It was found that addition of metals such as cobalt to the graphite electrodes resulted in extremely fine tube with single-layer walls. The availability of these structures should enable experimentalists to test some of the theoretical predictions that have been made about nanotube properties.

An alternative method of preparing single-walled nanotubes was described by Smalley's group in 1996. Like the original method of preparing C60, this involved the laser-vaporisation of graphite, and resulted in a high yield of single-walled tubes with unusually uniform diameters. These highly uniform tubes had a greater tendency to form aligned bundles than those prepared using arc-evaporation, and led Smalley to christen the bundles nanotube "ropes". Initial experiments indicated that the rope samples contained a very high proportion of nanotubes with a specific armchair structure. Subsequent work has suggested that the rope samples may be less homogeneous than originally thought. Nevertheless, the synthesis of nanotube ropes gave an important boost to nanotube research, and some of the most impressive work has been carried out on these samples.

Nanohorns

Single-walled carbon cones with morphologies similar to those of nanotube caps were first prepared by Peter Harris, Edman Tsang and colleagues in 1994. They were produced by high temperature heat treatments of fullerene soot. Sumio Iijima's group subsequently showed that they could also be produced by laser ablation of graphite, and gave them the name "nanohorns". This group has demonstrated that nanohorns have remarkable adsorptive and catalytic properties, and that they can be used as components of a new generation of fuel cells.

Nano-test-tubes

Among the highlights of nanotube research to date is the demonstration that tubes can be opened and filled with a variety of materials including biological molecules. There are Carbon and Nanotechnology Group who are working for more information and application regarding nano test tubes.

Nanoelectronics

Theorists have shown that nanotubes can be conducting or insulating depending on their structure. This may lead to applications in nanoelectronics.

Nanofibres

Theory also suggests that nanotubes should be immensely strong, so perhaps they will become "the ultimate carbon fibers".

Figure 6 shows the current CNT system in KUT and Figure 7 shows the fabrication of cobalt surface by KUT CNT research group.



Figure 6: CNT system in KUT

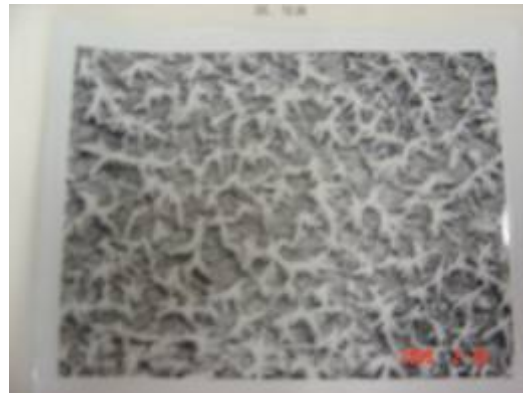


Figure 7: Fabrication of cobalt surface by KUT CNT

Conclusions

Mechanical engineers are universal worker and can work in the automotive, aerospace, chemical, computer, communication, paper, and power generation industries. It is true that mechanical engineers will be found in virtually any manufacturing industry. Now a day, mechanical engineers are needed in the environmental and bio-medical fields. Finally, every product or service in modern life has probably been touched in some way by a mechanical engineer. And KUT is trying to make a perfect mechanical engineer by its own technique and facility

References

1. S.Momota, Y. Nojiri, Y. Hamagawa, K. Hamaguchi, J. Taniguchi, H. Ohno, Application of highly charged Ar ion beams to ion beam lithography, Nuclear Instruments and Methods in Physics research B 242 (2006) 247-249.
2. Micro Manufacturing and Modification of Materials Using Ion Beam, S.Momota, Dept of Intelligent Mechanical System Engineering, Kochi University of Technology handbook.
3. Handbook on Ion sources by Bernhard Wolf, 1995 edition.
4. Kochi University of Technology Prospectus.
5. NEC Japan press release on <http://www.nec.co.jp/press/en/>