Medical Nanosystem Engineering

Fukushima Lab.

Dept. Mechanical Systems Engineering, Graduate School of Engineering

＊Please contact us if you want to visit our lab.

Assoc. Prof.
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In our laboratory, we can give students more opportunities to obtain the deep knowledge and a great deal of experience through advanced micro/nano-fabrication, integration, and assembly technologies in cleanroom. Students who can positively address challenges by themselves with logical thinking and never-give-up attitude are welcome.

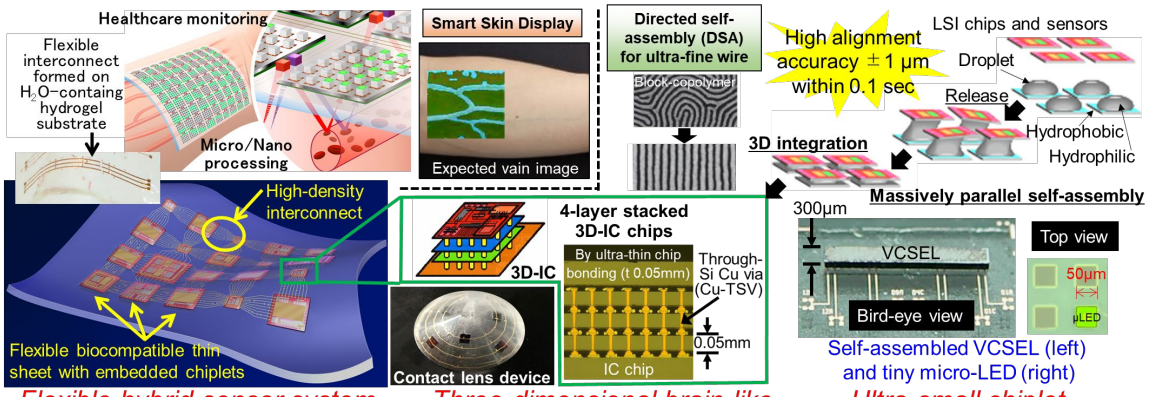
Presentation at international conferences are highly recommend.

The annual schedules of the conferences we often participate are as follows:

- ***May, IEEE Electronic Components and Technology Conference (ECTC)***
- ***Aug., IEEE International Flexible Electronics Technology Conference (IFETC)***
- ***Sept., International Conference on Solid State Devices and Materials (SSDM)***
- ***Oct., IEEE International 3D System Integration Conference (3DIC)***

We are working on specialized education and researches toward biomedical micro/nano integrated systems based on electronic packaging called *Jisso* engineering that involves interdisciplinary fields between material, mechanical, and electrical engineering. *Jisso* engineering is an essential science for the development of smart phones, wearable devices, humanoid robots, and so forth. Research activities of our laboratory aim to explore technological innovation to realize upcoming Internet of Everything (IoE) societies. In particular, our researches focus on the technologies of new "flexible hybrid electronics (FHE)" based on wafer-level packaging and tiny chiplets embedded in biocompatible film substrates. The advanced FHE are optimally designed with 3D integrated circuit (3D-IC), MEMS, optics, bio chips, and high-density interconnections to construct highly integrated heterogeneous flexible systems. We collaborate with T. Tanaka/H. Kino Lab.
The followings are current projects (Lab. URL: http://www.lbc.mech.tohoku.ac.jp):

1. Flexible device system integration technology for biomedical/healthcare applications
2. Three-dimensionally integrated chip technology for advanced neuromorphic computing
3. Self-assembly technology of tiny devices and ultra-fine pitch interconnects for future IoE society



Flexible hybrid sensor system integration technology | *Three-dimensional brain-like chip fabrication technology* | *Ultra-small chiplet self-assembly technology*

Flexible device system integration technology

We are fabricating 3D stacked retina prosthesis (3D image sensor) on flexible substrates to restore visual sensation for blind patients. This flexible system has wireless power supply components to achieve high QOL. We also developing flexible Si probes to cure brain diseases or analysis brain functions. So far, our laboratory has implemented multi-functional Si probes having micro-channels to deliver chemicals/drugs and optical waveguides to stimulate deep brain with photo signal. Various sensors will be assembled on the Si probes to create next-generation brain-machine interfaces (BMI). We collaborate with Faculty of Medicine and Graduate School of Information.

Three-dimensionally integrated chip technology

The human brain has 3D stacked structures that are electrochemically contacted through synaptic connections with extremely low power consumption without heat generation. For the next-generation brain computing chips, we are proceeding with the researches for high-performance 3D stacked IC that is electrically connected through 3D interconnects called TSV (Through-Silicon Via) with multi-functional polymer technologies. Upcoming automatic driving systems and neuromorphic computing will be produced with the 3D ICs.

Self-assembly nanotechnology of tiny devices

Self-assembly is an innovative process in which a disordered system of pre-existing components forms an organized small structure or micropatterns as a consequence of specific and local interactions among the components themselves without external forces. We have successfully self-assembled tiny ICs and optical chips within 100 nm in alignment accuracy using liquid surface tension as a driving force. This research is toward future wearable/implantable microsystems such as biomedical sensors and innovative micro-LED display application etc.