Department of Mechanical Systems Engineering, Graduate School of Engineering

Fukushima Lab.

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

Assoc. Prof.
Takafumi Fukushima

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.

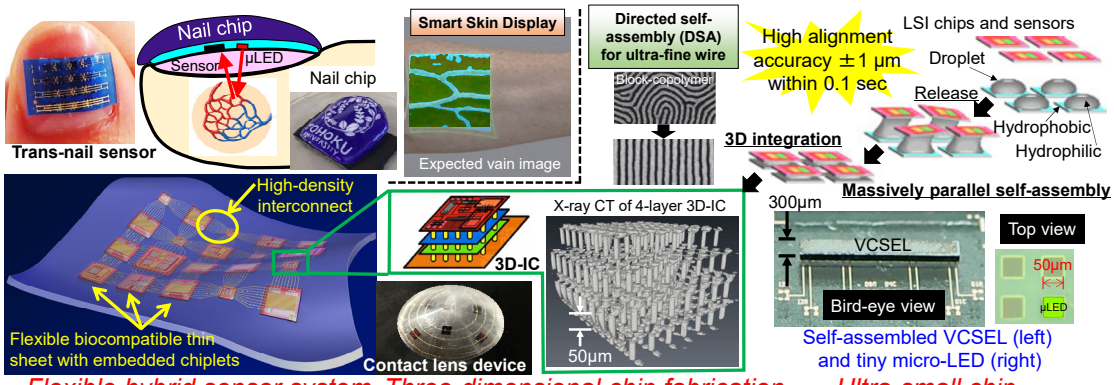
Presentation at international conferences are highly recommend.
The annual schedules of the conferences we often participate are as follows:

- ***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)***

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



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

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.

3D integrated chiplet 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 research 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.

Flexible device system integration technology

We are fabricating trans-nail SpO_2 sensor, contact lens devices, and Smart Skin Display for monitoring vital sign and blood flow etc. with chiplets embedded in flexible substrates to achieve high QOL. We also developing flexible neural probes to cure brain diseases or analysis brain functions. So far, our laboratory has implemented multi-functional flexible 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 flexible probes to create next-generation brain-machine interfaces (BMI). We collaborate with Faculty of Medicine and Graduate School of Information.