

智慧半導體系統研究中心

Smart Semiconductor System Research Center

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In recent years, the sensing technology and Internet of Things (IoT) have enabled paradigm shift of manufacturing, economics, and life pattern of human beings. The development of MEMS sensors integrated with CMOS using semiconductor technology becomes key to Smart-X applications, such as smart me, smart vehicle, smart manufacturing, smart city, etc. The IoT systems realized by these smart sensors show rapid growth and are widely used to drive the next-generation Semiconductor and ICT industries. Smart sensors are one of the most promising next-generation electronic/semiconductor technologies with enormous potential to energy savings, environmental sensing, safety sensing, and health diagnosis. Hence, the **NTHU Smart Semiconductor System Research Center (S³R Center**, cf. Fig. 1) has implemented our unique MEMS/IC fabrication platform to develop the integrated MEMS Sensor Hubs (Fig. 2). All of which would be integrated with interfaced circuits to be embedded into smart devices.

The S³R Center not only leverages the strength of semiconductor/MEMS/IC ecosystem (design house, foundry, packaging, and testing companies) in Taiwan but also extends its impact globally through our international collaboration. Fig. 3 presents the Europe-Taiwan MEMS Workshop hosted by PME/iNEMS, in which we invited MEMS pioneers from CEA-Leti France, KTH Sweden, KU Leuven Belgium, and U. of Freiburg Germany. There were more than 200 attendees with half of them from industry in Taiwan. On the other hand, PME/iNEMS actively visited other countries such as India and Vietnam for student/faculty exchange, dual-degree program, and research collaboration as shown in Fig. 4. We have visited India (universities: IISc, IIT-Bombay, IIT-Delhi, BITS Pilani, and CUSAT) more than 6 times in the past ten years while 3 times in Vietnam (HUST and VNU) in the past 5 years. Furthermore, NTHU PME/iNEMS is the sole member in Taiwan affiliated with the International Research Group NAMIS (comprised of 12 internationally reputable research organizations over nine countries).

Since 2019, PME/iNEMS has successfully recruited 3 Yushan Scholars, including Prof. Takehiko Kitamori (U. of Tokyo), Prof. Hiroyuki Fujita (U. of Tokyo), and Prof. Albert Shih (U. of Michigan). In particular, Prof. Kitamori has led a team at NTHU PME/iNEMS to collaborate with Japanese chemical company—Daicel—which will bring more than 4M USD in the next five years, focusing on chip-scale chemical factory (Fig. 5). PME/iNEMS also emphasizes on semiconductor/MEMS/Sensors education; for instance, we conducted industrial lectures every year as shown in Fig. 6 (2021 workshop event at NTHU) where most of the audience are from Semiconductor/MEMS design, foundry, packaging, and testing houses. By and large, it is expected that the target of the S³R Center can be applied to smart

wearable devices, customized sensing and manufacturing technologies, IoT applications, industry 4.0, and especially semiconductor in the future.

Smart Semiconductor System (S³) Research Center



Figure 1: Scope of the S³ research center covers international connection, industrial collaboration, and important applications (Semiconductor/Sensors and Industry 4.0/Smart X) emphasized by the Taiwan government.

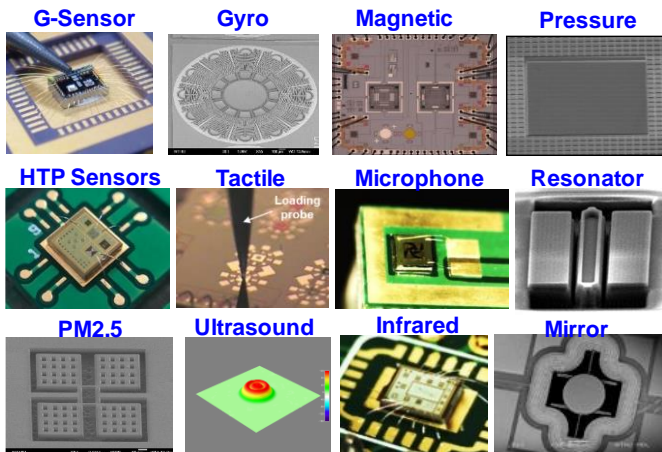


Figure 2: Semiconductor/MEMS Sensors developed by S³ research center, including environment hub, motion hub, acoustic hub, and actuator hub.



Figure 3: PME/iNEMS invited world-renowned scholars in Semiconductor/MEMS areas to deliver a MEMS Workshop at NTHU. Speakers from CEA-Leti France, KTH Sweden, KU Leuven Belgium, and U. of Freiburg Germany.



Figure 4: PME/iNEMS delegate visited India CUSAT team led by Vice Chancellor Dr. Madhusoodanan as well as Vietnam MOST for its 60th anniversary, where NTHU Chair Prof. Weileun Fang delivered a plenary talk.

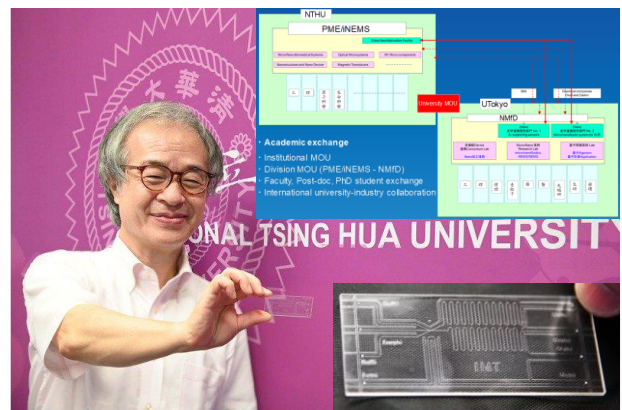


Figure 5: PME/iNEMS Yushan Scholar, Prof. Kitamori, has led a team at NTHU to establish an industrial collaboration with Daicel Japan, which will bring more than 4M USD in the next five years.



Figure 6: PME/iNEMS hosted a whole day Industrial Lecture on Semiconductor/MEMS fabrication, transducers, and their applications in IoT and smart X. There are more than 70 industry attendees from TSMC, MediaTek, APM, Sensortek, ASE, Xintec, TDK InvenSense, VIS, etc. covering Design House, Foundry, Packaging, and Testing in Semiconductor/MEMS, showing strong eco-system aligned with NTHU PME/iNEMS.