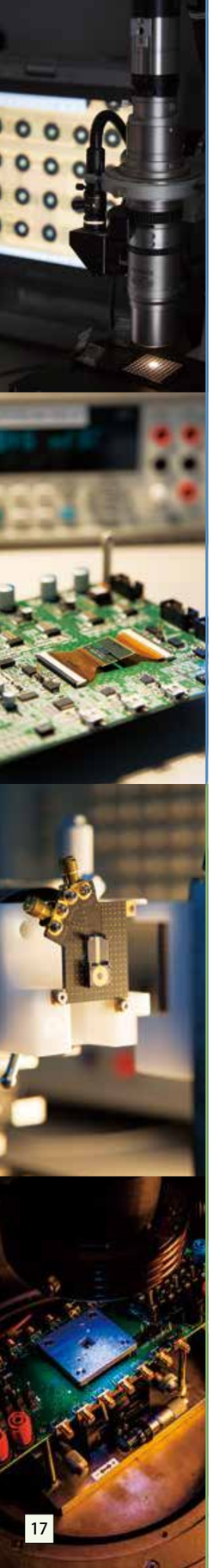


FY2015

Realization and Development of Innovative Information Processing System and Application Using Near-Field Coupling Integration Technology

"3D Integrated Chip" reduces power consumption to 1/1000

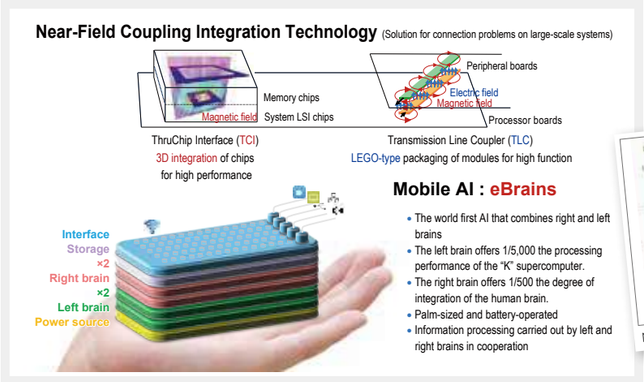
Recent years have seen dramatic increases in the information processing speed of computers and the amount of data being exchanged among them. Power consumption has also increased, however, leading to serious issues with equipment overheating and failing.

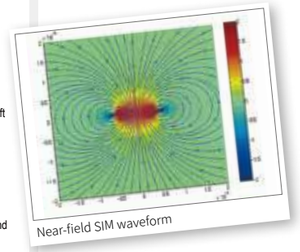
This is why our research, which permits drastic reductions in power consumption to prevent heat generation, is under the spotlight. By stacking chips three-dimensionally, or vertically, within an LSI (Large Scale Integration) and making the wireless communication between chips, we have succeeded in developing a technology that dramatically reduces power consumption to just one thousandth of conventional chips. This TCI (ThruChip Interface) technology enables data equivalent to six million two-hour movies (corresponding to 1400 years' worth of video recordings) to be transmitted using just the power equivalent to a single button battery. The TLC (Transmission Line Coupler) we have developed together with the TCI is a technology that allows non-contact connections between circuit boards and modules. This technology will cause fewer communication failures compared to wired connections, and offers advantages in terms of speed, size, weight, energy use, and cost, allowing this technology to be used in smartphones and artificial satellites.

Handling large volumes of data at high speed with ultra-low power consumption

In the ACCEL project, we plan to construct a system to handle large volumes of data at high speeds with ultra-low power consumption levels by stacking LSIs using TCI technology and connecting them wirelessly with peripheral devices such as sensors using TLC technology. This technology will result in significant advances in a range of fields that include supercomputers, robots, ultra-resolution microscopes, and automated driving.

Furthermore, we are advancing the development of the "eBrains" palm-sized artificial intelligence. This is the 3D integration of both a computer that has 1/5000th the processing performance of the "K" supercomputer, and an artificial intelligence that has a degree of integration 1/500th of the human brain. This incorporates the world's first system to carry out both logical/computational and intuitive/spatial information processing in combination.





Near-field coupling integration technology

The core idea of the TCI and TLC is how signals can be effectively sent back and forth between near-fields. The TCI employs a mechanism whereby the magnetic field coupling of coils on chips effectively allows data communication. The TLC enables wireless communication through the deformation of a part of the transmission line and the coupling of the electric and magnetic fields.

Research Director

Tadahiro Kuroda

Professor, Faculty of Science and Technology, Keio University

I have long been interested in power-saving technology, and during my frequent contacts with students who are beginners in electromagnetics at the university, I came up with the solution that communication between chips or transmission lines can be done through magnetic or electric fields. This "magnetic field coupling" and "electromagnetic field coupling" are based on very simple principles. However, no one had ever thought to use them for the transmission of digital data, making this idea truly a Columbus's egg. Now that performance improvements of integrated circuits is reached a dead end and the industry is suffering, it is time for the universities to step in.

In this ACCEL project, I am working towards the realization of my long-standing dream with the collaboration of the Program Manager, Dr. Kawamura, whom I have known for many years through conferences and so on. This work is also being done with the help of other colleagues who will advance this research together. Since both the TCI and TLC technologies use almost the same existing circuits, the technical challenges towards commercialization have already been solved.

Program Manager

Seiichiro Kawamura

ACCEL Program Manager, Japan Science and Technology Agency

TCI and TLC are innovative and practical technologies that raise the hope that we can succeed in making them practical parts of society in the near future. Risk, however, is inevitable in any R&D. Minimizing the overall risk is my chance to show my skill as the Program Manager.

In the ACCEL project, my role is to promote matching businesses based on needs accurately grasped and make our research results public. No matter how impressive ideas and results can be, it can be difficult to get industry to actually recognize and use them. As the Program Manager, I would like to connect research to industry and business, changing society using the technology originating from universities that was previously hard to commercialize.

Our proposal is to switch the connection of chips or circuit boards from a mechanical type using soldering or connectors to an electronic type such as near-field coupling.

Talking with people in the industry world, I realize they think very highly of the TCI and TLC technologies. My job is to draw up a plan to overcome the barriers of business.

The TCI and TLC technologies accelerate cutting-edge technologies such as supercomputers, artificial intelligence, and robots, making them a familiar part of our lives.

PROFILE TADAHIRO KURODA

1982: Graduated from the Department of Electrical Engineering, Faculty of Engineering, The University of Tokyo. Joined Toshiba Corporation; 2000 to present: Keio University, Professor since 2002. Field of expertise: System LSI chips. Ph.D. (Engineering)

PROFILE SEIICHIRO KAWAMURA

1974: Graduated from the Faculty of Engineering, The University of Tokyo; 1978: Graduate School of Princeton University, then Fujitsu. Worked for AIST, Semiconductor MIRAI project, Selete and, since 2008, JST. Experience in cooperation and management with many industry-academia-govt organizations. Ph.D. (Engineering)