Magnetic Data Storage Technology: From the Invention of Perpendicular Magnetic Recording to Social Integration
Yoichiro Tanaka
Tohoku University

The digital world is producing nearly a hundred zetta-bytes of data per year and creating value for the quality of society. A huge amount of data is being stored, processed, transmitted, and then shared via large-scale networked data centers, which consist of millions of data storage systems filled with perpendicular magnetic recording (PMR) hard disk drives. PMR technology was invented by Shunichi Iwasaki in 1975, and the first commercial product was launched in 2005. Since then, data storage has become the ever-growing foundation of the digital world and has led to data-driven innovations such as big-data artificial intelligence (AI) analytics, Internet of Things, medical science, and even black-hole visualization in astronomy.

This lecture will discuss the essential magnetics needed to understand innovative PMR data storage technology and the origin of the high-density recording performance that has led current recording density growth. Storage performance stands on a stacked system foundation and the building blocks are, from its base, the physics of magnetics, three-dimensional material controls at the subnanometer scale, magnetic and electronic device design, storage device integration, and storage system architectures, together with nonvolatile memory to unleash the system’s intrinsic performance. The development of new storage devices and systems requires a multiscale approach and the correct guiding principles to establish expected functions. As an extension of PMR research, the lecture will show the prospects for future storage technology and system architecture from the multiscale view of storage system development. New computational storage aiming at unifying computation power in data storage and brain-inspired systems, as well as the academic-industry relations to realize those systems, will also be introduced.

Bio
Yoichiro Tanaka is a professor in the Research Institute of Electrical Communication (RIEC) at Tohoku University. He received the bachelor’s and master’s degrees in Communications Engineering and the Ph.D. degree in Electronic Engineering from Tohoku University, where he did his thesis research on perpendicular magnetic recording physics and storage system integrations. He has worked in Toshiba’s storage device business and in academia for over 30 years. He is devoted to the proof and development of PMR and helped realize the world’s first PMR hard disk drive in 2005. His career includes the development of a giant magnetoresistive head, perpendicular granular thin film media, and, recently, new computational storage systems with integrated big-data analytics capability. He won Nikkei BP Technology Awards (1997, 2006), the Japan Magnetics Society Achievement Award (2006), and the Okochi Memorial Prize (2007). He is a senior member of the IEEE and a member of the Magnetics Society Administrative Committee for a three-year term, 2022-2024. He is a fellow of the Magnetics Society of Japan (MSJ). He is currently serving as Secretary General for the International Magnetics Conference (Intermag 2023, Sendai).