Preface
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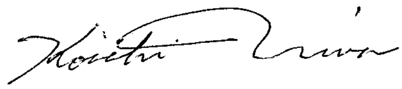

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The history of materials research over the past several centuries is full of glorious discoveries and innovations. In the first era of this period, researchers were focused on identifying the properties of materials that people were familiar with in their everyday lives. During the second era, researchers concentrated on developing new materials with new properties to enhance peoples' lives by integrating these materials into electronic devices. Finally, in today's computer era, research is devoted to the control of material properties, or in other words to the control material properties at the atomic and molecular scale. The degree to which we can exercise such control greatly depends on our evaluation technologies and equipment. It is vital that analysis is focused down to the atom layer that are being utilized in cutting-edge devices such as GMR heads and LSI gates. At Fujitsu Laboratories, numerous research programs are being conducted to develop evaluation and analytical techniques that match the technologies of state-of-the-art electronic devices, and have no detrimental effects on the environment.

The performance and reliability of electronic devices are deeply dependent on the properties of their materials. In particular, material properties have become more crucial due to the recent rapid progress in device integration densities and system densities. If we can find new materials with new functions by nanometer scale research, we will certainly make the future of electronics more attractive. In this regard, much attention has recently been paid to developing new materials for new applications, for example, conductive polymer electrodes for organic transistors and batteries and super-molecular materials for ultra-high density memory devices.

In general, materials are known by their bulk properties. However, sliced or cut portions of bulk materials are rarely used in electronic devices. Instead, most of today's electronics are made using thin films, the properties of which are notably different from those of bulk samples.

The 0.1 µm CMOS process, for example, is an ultra thin-film process that requires nano-scale processing technologies that include deposition methods, photolithography, etching, ashing, and polishing processes such as CMP. Among these technologies, we have achieved tremendous improvements in the material properties of the organic resists used in nano-scale photolithography. However, to remain a leader in this field, we must further improve these resists and then apply them in our mass-production lines.

Moreover, in 0.1 µm CMOS, various high-performance materials, for example, insulators, gate materials, and wiring materials, are essential for fabricating high-speed signal processors. In particular, low dielectric constant insulators and high-conductivity wiring materials are necessary to achieve fast signal propagation. In transistors, to avoid excessive leakage currents, high dielectric constant gate insulators that reduce the effective insulator thickness and increase the switching speed are essential.

Also, ferroelectric/dielectric materials such as PZT and BST are expected to provide high reliability in Ferroelectric Random Access Memory (FRAM) and low-inductance decoupling capacitors for GHz applications. Further, high-temperature superconducting ceramics with high Q-values, which are essential for low loss and high selectivity in RF filters, are promising materials in high-performance system devices.

Furthermore, optical transmission systems also require new cutting edge technologies and materials. For example, it is necessary to develop low-loss, high-speed switching systems that are inexpensive to produce. For lenses and waveguides, organic polymers should be developed as alternatives to inorganic materials such as SiO_2 optical glass. It is expected that, if polymers can satisfy the optical requirements, integrated optical circuits will soon be fabricated using the photolithographic technology that is used now to fabricate semiconductor LSIs.

Because of the growing environmental concerns and needs for sustainable development in recent years, significant research has been done to develop hazard-free materials. Due to our strong commitment towards a clean environment, Fujitsu has developed several eco-friendly materials, including Pb-free solders, recyclable Mg housings, halogen-free dielectric polymers, and biodegradable polymers.

Finally, I want to conclude by saying that further improvements in electronics, including higher performance with high reliability, size reduction, and cost reduction, mainly depend on materials research. Moreover, materials research and technology is absolutely necessary to differentiate our products from those of our competitors.