The minimum processing dimensions in the manufacture of large-scale silicon integrated circuits are approaching 2nm, and NAND memory requires microfabrication with a width of 90nm and an aspect ratio of more than 100, and unless the dimensional variation of this processing geometry is minimized, high-performance cell phones will be out of reach. Plasma nanoprocesses are used in more than 80% of large-scale integrated circuit manufacturing, and their evolution is directly related to their contributions to the permanent development of humanity with SDGs. Plasma nanoprocesses can be categorized into top-down processes, mainly etching, and bottom-up processes, such as nanostructure formation using plasma-induced self-assembled growth. Vertically grown nanographene processes, which can be formed by plasma-induced atomic reaction control, can form 3D microfabrication, widths of 2 nm and aspect ratios of 300 or more, structures that exceed those of top-down processes. In other words, there is a need to create advanced nanoprocesses that integrate top-down and bottom-up processes in the future.

This talk will cover the following topics: 1) Advances in the etching nanoprocess of ultrafine organic thin films by controlling radicals and substrate temperature in real time. 2) Growth of three-dimensional nanostructured thin films (vertically grown nanographene) by plasma-induced self-assembly. 3) The real-time measurements of atomic reactions between oxygen radicals and two-dimensional graphene. Finally, in order to realize these processes, it is important to establish low-temperature plasma process science, which requires the accumulation of databases that incorporate AI. For this purpose, it is necessary to develop measurement science. I would like to advocate the importance of in-situ observation of the synergistic effects of radicals and ions in plasma nanoprocesses and the establishment of a reliable database. In the near future, 3D nanopatterning by plasma nanoprocessing and self-assembly by biomolecules are also expected.

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References
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