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Recent development of Si chemical dry etching technologies

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Chemical dry etching in wafer processing was first developed by Horiike and Shibagaki (1976) using CF_4/O_2 downflow plasma for poly-Si etching, to prevent the degradation of the electrical properties of ICs due to the bombardment of charged particles. Thereafter, many researchers developed and reported various chemical dry etching methods.

Advanced Si chemical dry etching technology was developed by Tajima and Takahashi (2010), using N_2 downflow plasma and NF_3 flowing to the downflow plasma area. The etchant production mechanism for this technology was explained by us. In these technologies, the plasma source is necessary to produce the etchants (F for Si etching and $HF+NH_3$ for SiO_2 etching).

Recently, a novel Si chemical dry etching technology was developed by us without plasma source, in which F atoms generated in $F_2 + NO \rightarrow F + FNO$; reaction is used for Si etching. The etch rate at room temperature is more than 5 μm/min and is dependent on the flow rate and on the distance between the gas mixing point and the wafer position. Increasing the substrate temperature, the minimum etch rate was obtained at 60°C. Over this temperature, the etch rate increased again with increase of the substrate temperature. In the lower temperature region, the chemisorbed layer may be formed and the chemical reaction may be enhanced in this condensed layer. Increasing the temperature, this chemisorbed layer disappears around 60°C. Over this temperature, the surface reaction mainly takes place according to Arrhenius equation.

Biography

Toshio Hayashi has completed his Ph.D. for molecular orbital calculations of organic compounds on 1976 from Tohoku University. He was the senior research manager of ULVAC Inc., and joined with Nagoya University on 2006. He has published more than 42 papers in reputed journals and patented over 80, and served as a reviewer of *Jpn. J. Appl. Phys* and an editorial committee member of *J. Vac. Soc. Jpn*. and serving as a program committee member of DPS-2013 symposium.

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