TF-P065

Real-Time Spacer Etch-End Point Detection (SE-EPD) for Self-aligned Double Patterning (SADP) Process

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Double patterning technology (DPT) has been suggested as a promising candidates of the next generation lithography technology in FLASH and DRAM manufacturing in sub-40nm technology node. DPT enables to overcome the physical limitation of optical lithography, and it is expected to be continued as long as e-beam lithography takes place in manufacturing. Several different processes for DPT are currently available in practice, and they are litho-litho-etch (LLE), litho-etch-litho-etch (LELE), litho-freeze-litho-etch (LFLE), and self-aligned double patterning (SADP) [1]. The self-aligned approach is regarded as more suitable for mass production, but it requires precise control of sidewall space etch profile for the exact definition of hard mask layer. In this paper, we propose etch end point detection (EPD) in spacer etching to precisely control sidewall profile in SADP. Conventional etch EPD notify the end point after or on-set of a layer being etched is removed, but the EPD in spacer etch should land-off exactly after surface removal while the spacer is still remained. Precise control of real-time in-situ EPD may help to control the size of spacer to realize desired pattern geometry. To demonstrate the capability of spacer-etch EPD, we fabricated metal line structure on silicon dioxide layer and spacer deposition layer with silicon nitride. While blanket etch of the spacer layer takes place in inductively coupled plasma-reactive ion etching (ICP-RIE), in-situ monitoring of plasma chemistry is performed using optical emission spectroscopy (OES), and the acquired data is stored in a local computer. Through offline analysis of the acquired OES data with respect to etch gas and by-product chemistry, a representative EPD time traces signal is derived. We found that the SE-EPD is useful for precise control of spacer etching in DPT, and we are continuously developing real-time SE-EPD methodology employing cumulative sum (CUSUM) control chart [2].

References

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Keywords: Douple pattering, Spacer etch, End point detection