

Dry Etching of Ge by Using CHF₃ Inductively Coupled Plasma for Ge Waveguides

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Germanium has been demonstrated to be a silicon process compatible material to realize active and passive photonic devices including laser diodes and waveguides [1-2].

With regards to etching of waveguides, SF₆ has been widely used to etch precisely for Si-photonics [3]. However, using SF₆ to etch Ge produces an under-cut effect that adversely reduces the width of the waveguide.

The research was published in Electronic Letters [4] and was presented in MOC 2015 [5] showed precision etching of Ge waveguide width by eliminating the under-cut issue and achieving a near vertical sidewall by using CHF₃ inductively coupled plasma (ICP).

Figure 1 shows the cross-sectional views using CHF₃ ICP etching for Ge. The etching depth was around 190 nm that approximately corresponds to the core thickness of a Ge waveguide. Almost no under-cut was observed especially for 800 W to 1200 W ICP decomposition power.

Figure 2 shows the accurate dimensional control of CHF₃ ICP dry etching of Ge even with narrow waveguide widths of 2 μm.

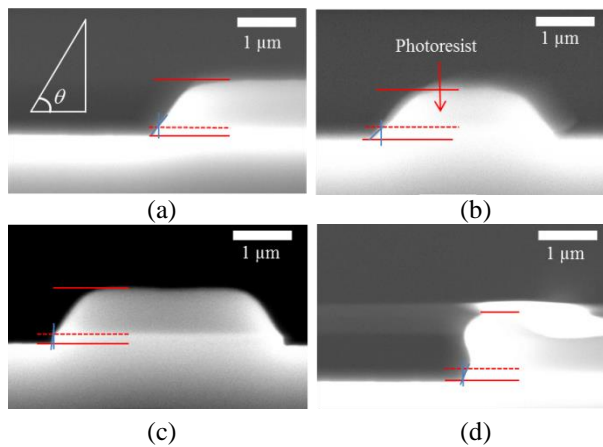


Fig. 1 Cross sectional view of Ge. ICP power and sidewall angle θ for; (a) 800 W (50°), (b) 1000 W (55°) (c) 1200 W (85°) (d) 1400 W (70°)

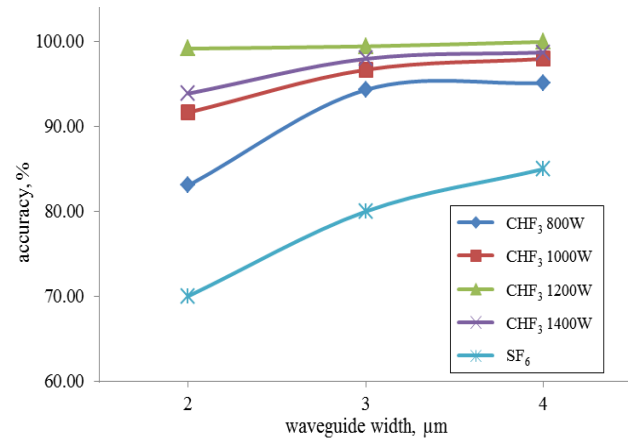


Fig. 2 Comparison of etched waveguide widths accuracy with widths from 2 to 4 μm for various CHF₃ ICP power and SF₆ ICP dry etching.

We have researched ICP dry etching using CHF₃ to etch Ge using photoresist mask to produce a near vertical sidewall angle of 85° and a relatively highly selectivity of 5:1 (Ge:photoresist). The use of CHF₃ ICP will provide the ability to etch Ge optical waveguides with precise width control.

Reference

- [1] J. Michel et al., OFC/NFOEC, PDP5A.6 (2012).
- [2] T. Okomura et al., MOC2015, J4 (2015).
- [3] S. Grigoropoulos et al., J. Vac. Sci. Tech., B15, 640 (1997).
- [4] A.S. Idris et al., Electron. Lett., 52, 22 (2016).
- [5] A.S. Idris et al., MOC2015, H23 (2015).