

**[T-03]**

## **Catalytic Effects of Ar addition for High-rate Dry etching of Ga-based compound semiconductors in High-Density Planar Inductively Coupled BCl<sub>3</sub>/Ar Plasmas**

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We found catalytic effects of Ar addition in high-density planar inductively coupled BCl<sub>3</sub>/Ar plasma etching of Ga-based semiconductors. The etch rate of GaAs in 15BCl<sub>3</sub>/5Ar, 7.5 mTorr, 300 W ICP, 100 W RIE was > 1  $\mu\text{m}/\text{min}$  while that of GaAs at 20 BCl<sub>3</sub> with the same condition was only 0.4  $\mu\text{m}/\text{min}$ . The result was same with AlGaAs. We further investigated % Ar effect on planar ICP etching of Ga-based semiconductors in BCl<sub>3</sub>/Ar plasma composition. A pure Ar planar ICP plasma at 20Ar, 300 W ICP, 100 W RIE and 7.5 mTorr etched < 500 Å after 3 minute run on GaAs and AlGaAs, while all the photoresist patterns were eroded and disappeared by physical sputtering of the energetic Ar plasma. However, we achieved very high etch rates of GaAs at 5BCl<sub>3</sub>/15Ar, 10BCl<sub>3</sub>/10Ar and 15BCl<sub>3</sub>/5Ar. The etch rates were even higher than 1  $\mu\text{m}/\text{min}$  in 10BCl<sub>3</sub>/10Ar and 15BCl<sub>3</sub>/5Ar composition. Extensive characterization was carried on the GaAs processed at 15BCl<sub>3</sub>/5Ar plasma. AFM data showed very smooth surface of the etched GaAs. The smoothness was confirmed with SEM micrographs. However, it is noticed that a slight undercutting existed at the bottom of the etched GaAs sidewall, while overall sidewall was quite vertical at 15 BCl<sub>3</sub>/5Ar ICP etching. We believed that Ar addition to a planar BCl<sub>3</sub> ICP produced more BCl<sub>3</sub> neutrals and/or assisted fast desorption of Ga-based etch products, such as GaCl<sub>x</sub>, with heating-up of substrate by Ar ion bombardment at fixed electrode temperature. It was also noticed that selectivity of GaAs to a PR mask was improved to 10:1 at 5Ar/15BCl<sub>3</sub> from 3:1 at 20BCl<sub>3</sub> alone. No PR burning was observed. Ar addition to BCl<sub>3</sub> planar inductively coupled plasma could be beneficial for high etch rates and selectivity of Ga-based semiconductors.