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Investigation of GaAs over AlGaAs and InGaP Selective Dry Etching in Planar Inductively Coupled Plasmas with BCl_3/SF_6 based Chemistries

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We investigated selective dry etching of GaAs over AlGaAs and InGaP in planar inductively coupled plasmas with BCl_3/SF_6 based chemistries. The process parameters were ICP source power (0 - 500 W), RF chuck power (0 - 30 W) and gas composition (60 -100% BCl_3 in BCl_3/SF_6 and addition of inert gases at fixed $18BCl_3/2SF_6$). The process results were characterized in terms of etch rate, selectivity of GaAs, surface morphology, surface roughness and residues after etching. BCl_3/SF_6 selective etching of GaAs over AlGaAs and InGaP showed quite good results in this study. Selectivities of GaAs (GaAs:AlGaAs ~ 36 : 1, GaAs:InGaP ~ 45 : 1) were superior at $18BCl_3/2SF_6$, 20W RF chuck power, 300W ICP source power and 7.5 mTorr. Addition of SF_6 to BCl_3 (5 - 15%) produced relatively high selectivities of GaAs over AlGaAs and InGaP during etching due to decrease of etch rates of AlGaAs and InGaP etch rates at the condition. Addition of inert gases(Ar, Ne, He, N2) to $18BCl_3/2SF_6$ plasma produced higher selectivities of GaAs over AlGaAs(max ~ 71) and InGaP (max ~ 91) than those at pure $18BCl_3/2SF_6$ plasma condition. Both SEM and AFM data showed slightly sloped sidewall and somewhat rough surface(RMS ~ 9 nm) of etched samples. XPS study on the surface of processed GaAs proved a very clean surface after dry etching. It showed that a planar inductively coupled BCl_3/SF_6 plasma could be a good candidate for selective dry etching of GaAs over AlGaAs and InGaP.