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Molecular ion sources for semiconductor ion implantation*

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As semiconductors become smaller shallow implantation is desired and ion energy needed for implantation decreases, resulting space charge (intra-ion repulsion) effects, which reduced beam currents and production rates. To increase production rates, molecular ions are used. Boron and phosphorous (or arsenic) ion implantation are needed for P-type and N-type semiconductors respectively. Carborane, which is the most stable molecular boron ion leaves unacceptable carbon residue on extraction grids. A self-cleaning carborane compound was synthesized: the m isomer of m-carborane-1,7-dicarboxylic acid ($C_4H_{12}B_{10}O_4$), when utilized in the ITEP Bernas ion source resulted in large carborane ion output, without carbon residue. Ion source acid operation at high temperatures still had carbon residue, which was remedied by a special O_2 elliptical cross section dissociator that injected miniscule amounts of O unto the grid prevented carbon deposition without loading up power supplies. Pure gaseous processes are desired for enable rapid switch among ion species. Molecular phosphorous was generated by introducing phosphine in dissociators via $4PH_3 = P_4 + 6H_2$ generated molecular phosphorous in a pure gaseous process (same applies for arsenic AsH_3). Molecular phosphorous was then injected into the HCEI Calutron-Bernas ion source, from which P_4^+ ion beams were extracted. For avoiding the use of ovens in deep implantation, high charge state phosphorous and arsenic can be generated by driving the HCEI Calutron-Bernas ion source harder and absorbing the hydrogen molecules in Pd after the dissociator. Results from devices and some additional concepts will be presented.

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