Ultra-Shallow Junction Formation by Gas Immersion Laser Doping (GILD)

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Gas Immersion Laser Doping (GILD) is a very attractive technique to realize the ultra-shallow and highly doped junctions required by the International Technology Roadmap for Semiconductors (ITRS) for future CMOS technologies.

In the present paper, gaseous dopant precursors (BCl_3) are chemisorbed on the silicon surface, and partially incorporated during the melting / recrystallisation of the Si top layer induced by an UV laser pulse (λ = 308 nm, pulse duration ≈ 25 ns) [1]. The resulting thickness and dopant concentration of the doped layer depend on the laser energy density and the number of chemisorption / laser-induced incorporation cycles (up to 200).

The GILD process is followed in situ, at each laser pulse, by time resolved optical diagnostics, which allow for an evaluation of the activated doped layer thickness [2]. Four-point probe resistivity measurements and secondary ion mass spectrometry (SIMS) depth profiles (figure 1) show that the GILD processed junctions are box-like and exhibit depths ranging from 14 nm to 65 nm, with sheet resistances ranging from ≈ 110 to 20 Ω/□, respectively (see figure 2), dopant concentrations well above the B solubility limit in Si (up to $3x10^{21}$ / cm^3) and abruptness of 5 ± 2 nm / decade. Moreover, in situ optical characterization shows the GILD technique capabilities to realize the sub-10 nm thick shallow junctions needed for the sub-40 nm node ITRS predictions.

1. G. Kerrien, J. Boulmer, D. Débarre, D. Bouchier, A. Grouillet., D. Lenoble, Appl. Surf. Sci. **186** (2002) 45

2. G. Kerrien, M. Hernandez, C. Laviron, T. Sarnet, D. Débarre, T. Noguchi, D. Zahorski, J. Venturini, M.N. Semeria, J. Boulmer, EMRS Spring Meeting, Strasbourg, France, June 2002, to be published in Appl. Surf. Sci.

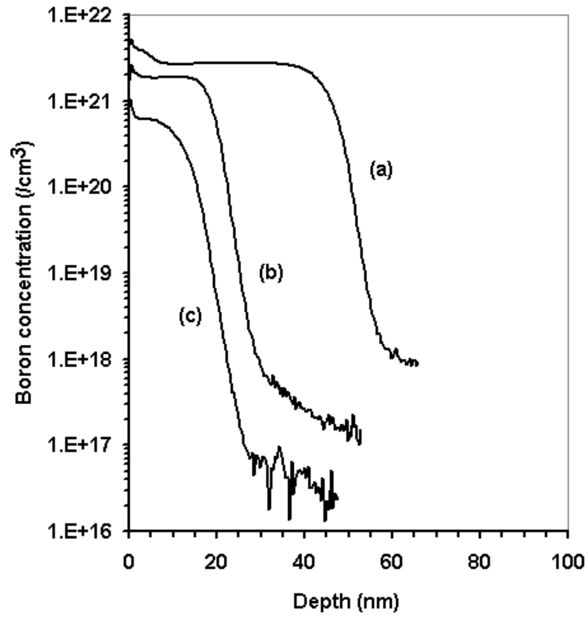

Figure 1: SIMS depth profiles of B doped layers realized by GILD at 660 mJ/cm², with 20 (curve c), 50 (curve b) and 200 (curve a) laser pulses.

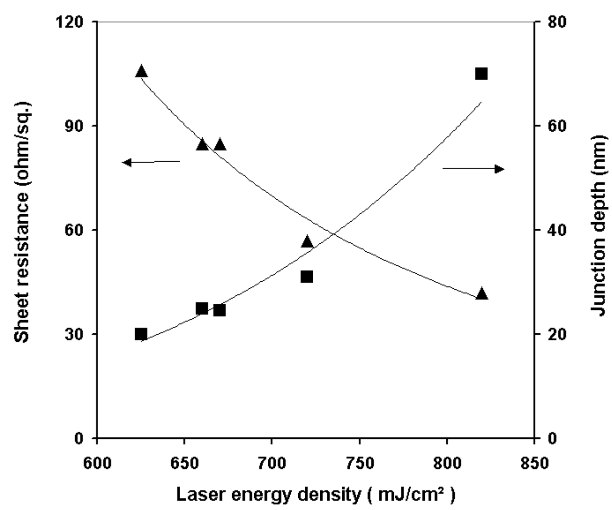

Figure 2: Sheet resistance (triangles) and sheet resistance (squares) of GILD processed junctions as a function of the laser energy density (50 laser pulses).