High-pass Energy filtered PEEM Imaging of Dopants in Silicon

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The study has been focused on the origin of contrast between differently doped areas in Si, observed in a high-pass energy filter equipped PEEM. The native-oxide covered samples of both p- and n-type with dopant concentrations of 10^{15} to 10^{19} cm^{-3} were observed. For the strong p/n contrast (with the p-type brighter) not only doping-induced changes in the photothreshold [1] but also electron absorption phenomena [2] have been found responsible. While in the full photoemission the contrast disappears when decreasing the dopant concentration, the inverted, fast-electron carried contrast remains preserved (Fig. 1). The energy spectra exhibit some structure possibly connected with multiple sources of photoelectrons, and the photothreshold difference between p- and n-type increases up to 0.2 eV at the highest concentrations (Fig. 1). [3]

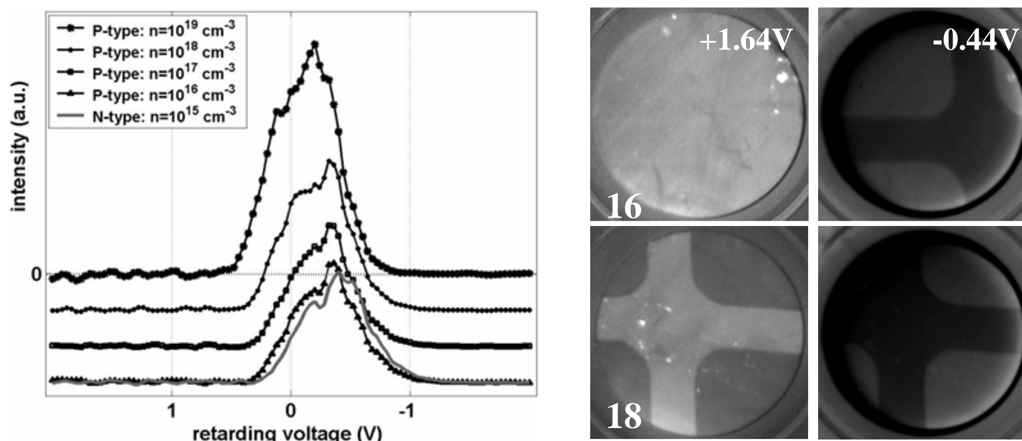

Fig. 1: *Left:* Energy spectra of average photoemission signals from p-type doped patterns (dopant concentrations top to bottom: 10^{19} to 10^{16} cm^{-3}) on the 10^{15} cm^{-3} n-type substrate. (Zero intensity levels are stepwise offset for clarity.) *Right:* PEEM images of p-type patterns doped to 10^{16} (top) and 10^{18} (bottom) cm^{-3} on the 10^{15} cm^{-3} n-type substrate for the energy filter biased to +1.64 V (left column, full photoemission) and to -0.44 V (right column, fast photoelectrons).

[1] Ballarotto V. W. *et al.*, J. Appl. Phys. **91** (2002) 469.
[2] Frank L. *et al.*, Proc. Microsc. Conference [6th Dreiländertagung], Davos 2005, 321; these Proceedings.
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