

Low-energy WDS: Depth Profiling PLAD Deposited Boron

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Advanced CMOS technologies required junctions shallower than 25 nm, making low energy (500-1000 eV) plasma deposition (PLAD) of boron in silicon an attractive method of ultra shallow semiconductor doping. Such narrow junctions are typically characterized using destructive techniques such as SIMS. The ultra-high vacuum (UHV) requirements of SIMS and other surface sensitive spectroscopies such as Auger electron spectroscopy and X-ray photoelectron spectroscopy make such analysis costly and not well suited for fab-line diagnostics or *in-situ* deposition monitoring.

Figure 1 below shows the BK_{α} peak taken with $2d = 200\text{\AA}$ for a $1 \times 10^{15} \text{ cm}^{-2}$ 1keV PLAD deposited junction in Si. The data was taken at varying electron beam energies to control the information depth of the WDS analysis by controlling the electron range in the sample. All spectra were taken with a very modest 10 nA probe current. The 10kV data shows little evidence of BK_{α} signal as mostly the undoped sample bulk is being probed. As the electron beam energy is reduced, more of the PLAD deposited B-doped Si layer is probed, resulting in an increase of the BK_{α} peak-to-background and net BK_{α} net peak area and height. At 2kV the high energy end of the background is suppressed due to a significant reduction in X-ray continuum background as the excitation threshold of the Si Ka peak is approached.

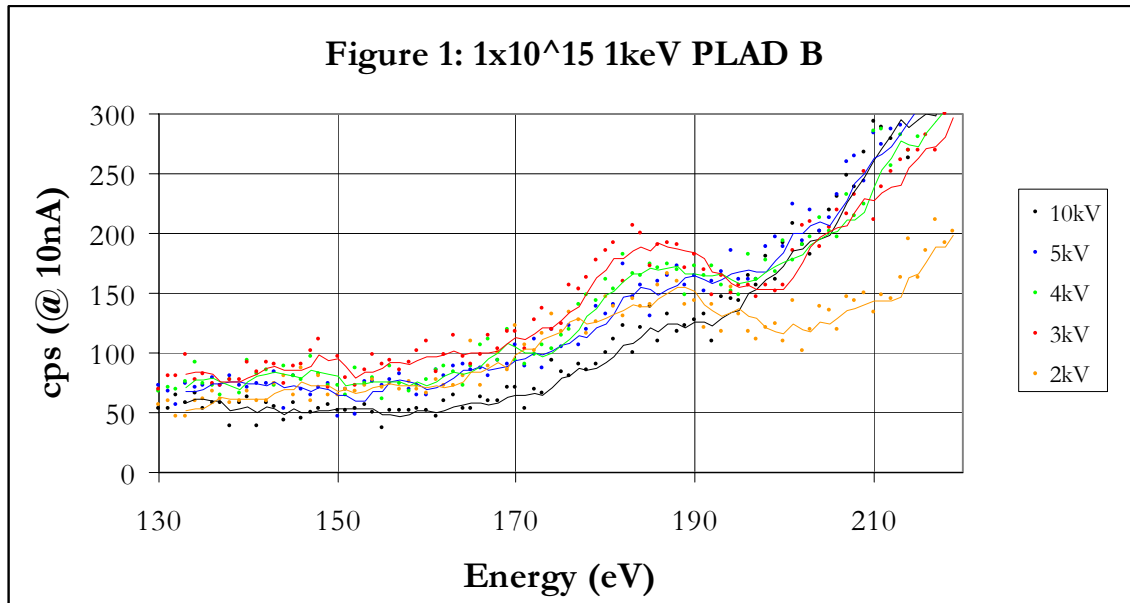
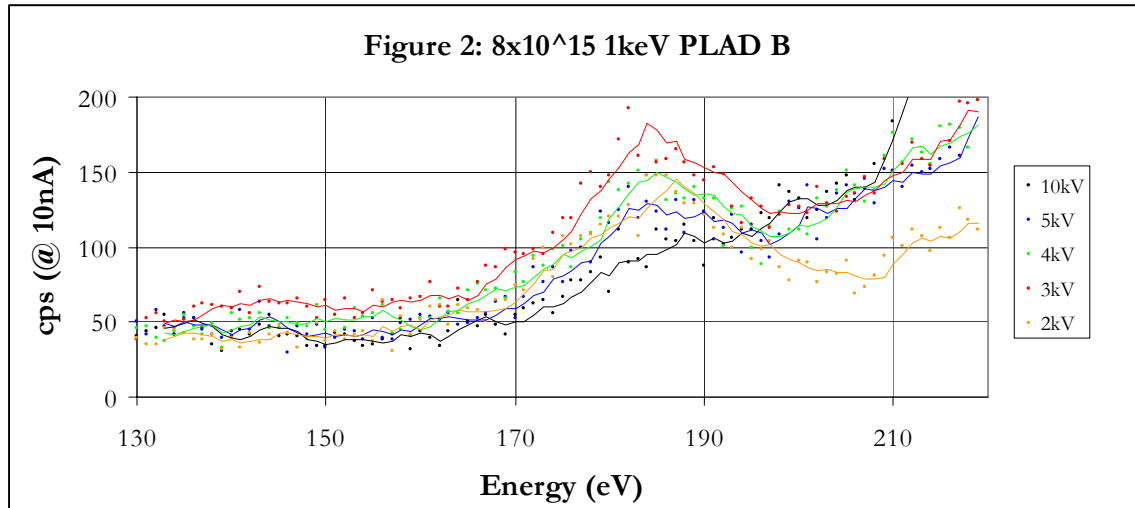


Figure 2 below shows a similar set of data for a $8 \times 10^{15} \text{ cm}^{-2}$ 1keV PLAD deposited junction in Si. As above, the data was taken with a $2d = 200 \text{ \AA}$ with a modest 10nA probe current. Again, the 10kV data shows very little evidence of the BK_{α} peak, with increased P/B and net BK_{α} peak height and areas as the electron beam energy is reduced.



These WDS scans were performed with HexLEXS using 1eV steps and 1s dwell times for a total scan time of ~ 100 s. Even with these very small acquisition times and modest 10nA probe currents, depth profiling of very shallow—on the order of 20-30nm—boron junctions can be probed in an SEM. This is of particular interest as contemporary SEM's are well suited to low-voltage work, often providing beam energies in 100eV increments from 100-300 eV up to 3000eV.