An Extreme Application: B-doped Si with LoMaX

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The detection of boron in B-doped Si is of great interest in the characterization of shallow p-type junctions created by either ion implantation or plasma deposition (PLAD). The distribution of boron in a p-type junction can be studied either by SIMS or by WDS by varying the electron beam excitation energy and thereby the electron range in the specimen. However, even with "light element" EDS systems the detection of boron in such bulk systems as BN is difficult—not to mention the detection of low-concentration boron dopants.

Figure 1. Ion Implanted B in Si with LoMaX

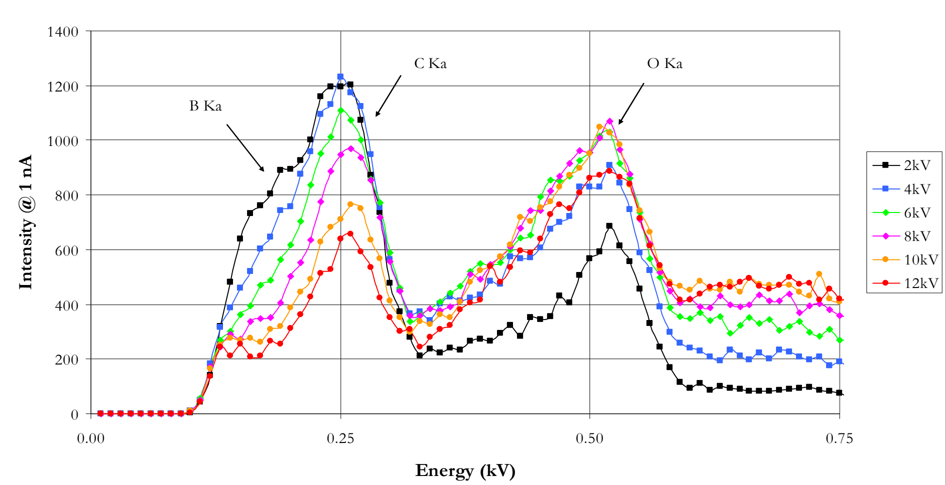

Figure 1 above shows EDS data taken with the LoMaX on B-doped Si using 1 nA of beam current from 2-12 kV in 2 kV increments. Since the boron is segregated near the sample surface, the B Ka signal *increases* as the beam energy *decreases* and the electron energy loss region is limited to the area near the sample surface. A very prominent B K_α X-ray peak-- ~ 800 cps/nA-- is seen to the left of the C K_α peak at 2 kV. By the time the electron beam energy decreases to 8 kV it has all but disappeared.

There is some variation in the O K_α X-ray line intensity between 4 kV and 12 kV—about 15%-- but this is attributed to variations in the surface oxide layer due to cleaning and handling: each measurement corresponds to a different point on the sample surface as the probe current was measured in a Faraday cup between measurements. The O K_α signal shows a significant jump between 2 kV and 4 kV due to the increased excitation efficiency of the O K_α line above 2 kV. The high-energy background at 0.75 kV decreases with electron beam energy due to decreased continuum production.

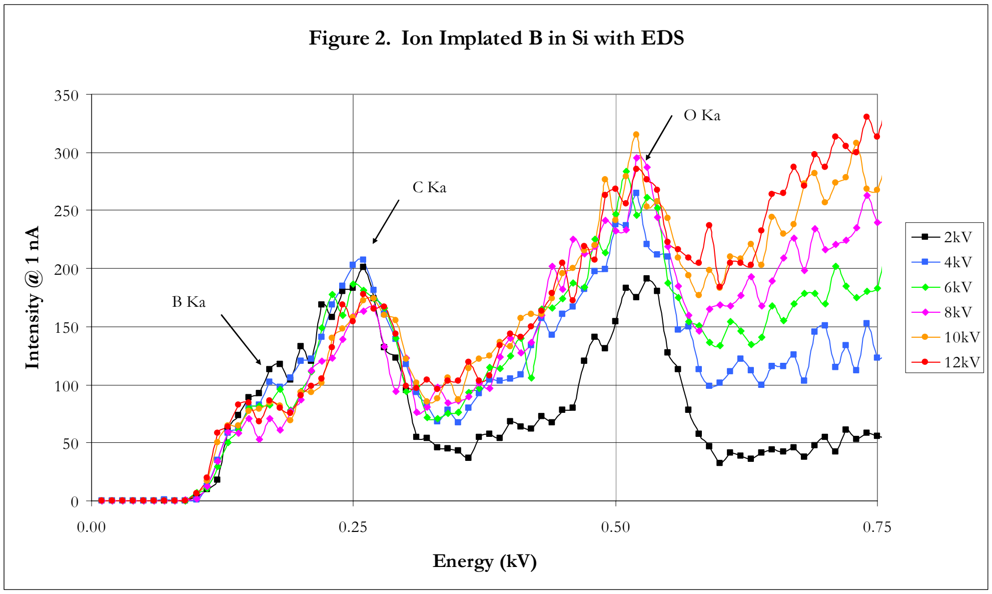

Figure 2 above shows the same data-set except without the LoMaX. Immediately evident is the gain of ~ 6 for C K_α and ~ 3.5 for O K_α using the Lomax. The same general trends are visible in the data—background at 0.75 kV decreasing with beam energy, jump in O K_α intensity between 2 kV and 4 kV, *etc.*—but B K_α can just barely be detected. Any systematic changes in B K_α signal with electron beam energy are statistically uncertain.

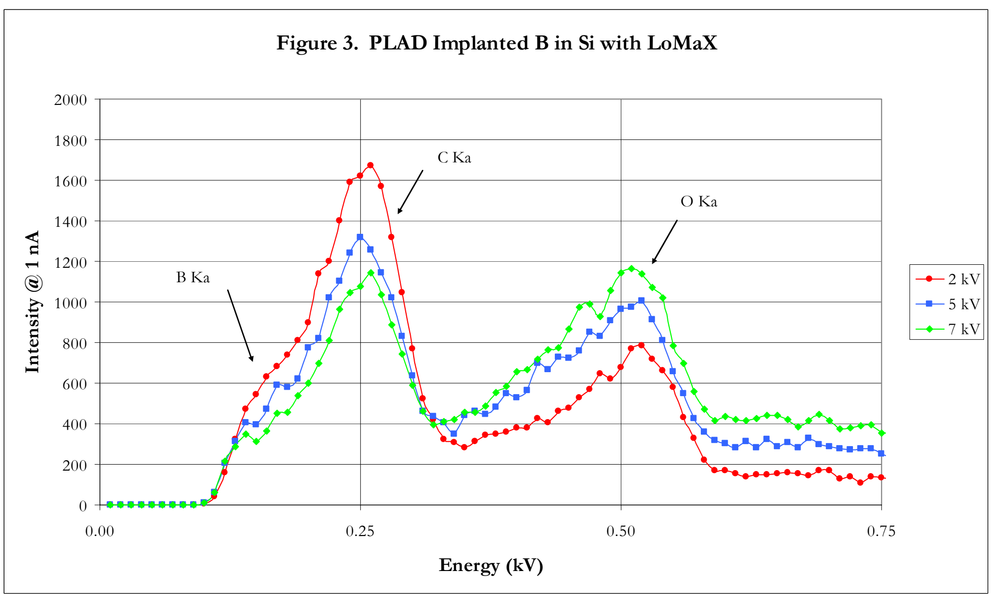

Figure 3 above shows the most extreme application— the application of LoMaX to a 1kV BF_3 PLAD implanted shallow (~ 25 nm) junction in silicon. The B Ka X-ray line detectable at 2 kV is barely visible at 5 kV and entirely gone at 7 kV due to the extreme shallowness of the boron doping using the PLAD technique. Such an application is without a doubt entirely outside the scope of traditional EDS.