

Fluorescence yield XAFS spectrometer for light elements (B, C, N, O) in semiconductor materials

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ABSTRACT

Light elements such as boron, carbon, nitrogen, and oxygen play important roles for silicon and compound semiconductor devices. They influence electronic properties as dopants or impurities. The measurement of the structural and electronic properties of those light elements is challenging. Atom probe and TEM provide atomic-scale distribution and lattice images, but we normally cannot analyze the lattice location of the light elements. X-ray absorption fine structure (XAFS) spectroscopy complements atom probe and TEM data, although spatial resolution is not in nanometer scale. XAFS measurements for impurities in matrices are frequently performed by using fluorescence x-rays at synchrotron radiation beam lines. However, the light elements in semiconductor materials are difficult to detect with energy dispersive x-ray (EDX) detectors, because of the low energies of fluorescence x-rays in a range of 183 – 525 eV. The situation gets worse when the matrices are wide band gap semiconductors such as SiC, ZnO, and diamond. Spectral overlap between the impurities and the matrix elements obscures the information of the target impurities.

Our solution to realized fluorescence yield XAFS for the light elements is to use a superconducting EDX spectrometer, which has a high energy resolution of better than 20 eV@ N K α : 392 eV and an expected counting rate of over 1 Mcps.¹ The prototype XAFS spectrometer is shown in Fig. 1.

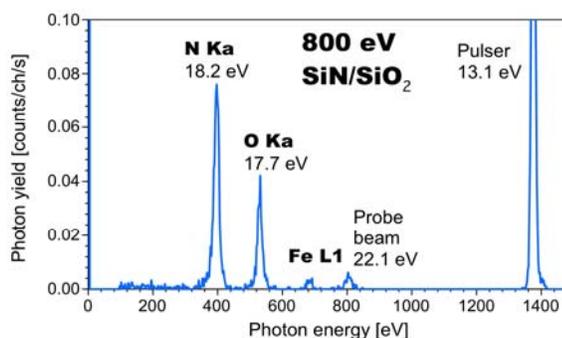


FIGURE 1. XAFS spectrometer equipped with a superconducting EDX detector system and energy resolution for the light elements at a KEK PF beam line.

REFERENCES

1. S. Shiki, N. Zen, M. Ukibe, and M. Ohkubo, *AIP Conf. Proc.* **1185**, 409 (2009).
Light element, Impurity, XAFS, Energy-dispersive x-ray spectroscopy, Superconducting detector