XRS for Li-ion batteries

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X-ray Raman Scattering (XRS) is a promising tool to characterize the changes in electronic structure in materials for Li-ion batteries. At small momentum transfer, the dynamic structure factor of XRS spectrum is proportional to the X-ray absorption spectrum. However, while it enables the probing of low Z elements, it is based on hard X-rays, which have larger penetration depth, rendering the method sensitive to the bulk rather than the surface, where spurious side reactions may occur that generate products that dominate the spectra. Proof of the power of the technique is presented here with a study of the lithiation of graphite with lithium and carbon K-edge XRS. The graphite electrode is the ubiquitous choice in current Li-ion batteries, including those used in electric drive vehicles. Despite the extensive work on this system over the years, details on the change in the nature of the bonding and electronic structure during lithiation/delithiation remain unknown. Advances in the use of XRS to characterize this system both ex situ and in operando will be presented. Experiments were performed at beam line 6-2 at the Stanford Synchrotron Radiation Lightsource (SSRL).