Hole distribution of intercalated cuprates using soft-x-ray absorption spectroscopy


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The unoccupied electronic states of X-Bi$_2$Sr$_2$CaCu$_2$O$_8$ (X-Bi2212, X = I, HgI$_2$, and (Py-CH$_3_2$)$_2$HgI$_4$, Py = pyridine) have been probed by O K-edge and Cu L$_{2,3}$-edge x-ray absorption near-edge structure (XANES) spectra using a bulk-sensitive x-ray-fluorescence-yield technique. In the O 1s absorption edge of X-Bi2212, the pre-edge peak at ~ 528.3 eV is attributed to transitions into the O 2p hole states located in the CuO$_2$ planes. As deduced from O K-edge and Cu L-edge x-ray absorption spectra, the hole concentration in the CuO$_2$ planes of X-Bi2212 increases for X = I and HgI$_2$, while it depresses for X = (Py-CH$_3_2$)$_2$HgI$_4$ as compared to pristine Bi2212. These results are consistent with theoretical predictions based on extended Hückel tight-binding band calculation. The present XANES results clearly demonstrate that the hole density within the CuO$_2$ planes of intercalated Bi$_2$Sr$_2$CaCu$_2$O$_8$ can be not only reduced but also increased depending on the chemical character of the intercalants.