SLOW ELECTRON VELOCITY-MAP IMAGING OF $La_2(C_6H_6)$ AND $La(C_6H_6)_2$

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Slow electron velocity-map imaging (SEVI) was used to study the structures and electronic states of $La_2(C_6H_6)$ and $La(C_6H_6)_2$ complexes formed in a metal cluster beam source. Electron spectra obtained from SEVI have the energy resolution of ΔE/eKE $\approx 2\%$ at eKE=400cm^{-1}. The SEVI technique offers much higher data collection efficiency than pulsed-field ionization zero electron kinetic energy spectroscopy. From the SEVI spectra, adiabatic ionization energies were measured to be 32141(5) cm^{-1} for $La_2(C_6H_6)$ and 39033(5) cm^{-1} for $La(C_6H_6)_2$. The most active vibrational transition for both complexes was identified to be a metal-ligand stretching mode with a frequency of 180 cm^{-1} in the ion state. In addition, a benzene ring out-of-plane deformation mode was measured to be 303 cm^{-1} for $[La_2(C_6H_6)]^+$ and 408 cm^{-1} for $[La(C_6H_6)_2]^+$. By combining the spectra with theoretical calculations, we identified the $^2A_g \leftarrow {}^1A_g$ transition of $La_2(C_6H_6)$ (C_{2h}) and $^3A \leftarrow {}^2A$ of $La(C_6H_6)_2$ (C_1). By measuring the anisotropy parameter (β) from photoelectron angular distribution, we found that the outgoing electron was from a largely La 6s-based molecular orbital in both complexes.