Supporting Information

CO Activation on the Late Lanthanide Dimers: Matrix Infrared Spectra of the $Ln_2[\eta^2(\mu_2\text{-C, O})]_x$ (Ln = Tb, Dy, Ho, Er, Lu; x = 1, 2) Molecules

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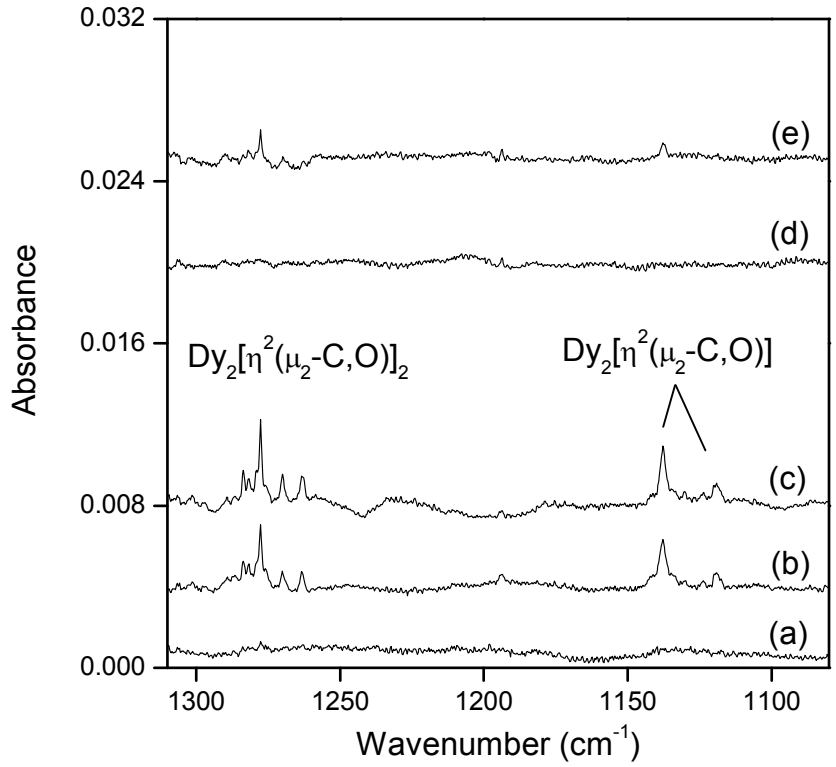

Figure S1. IR spectra in the 1300–1100 cm^{-1} region for laser-ablated Dy atoms co-deposited with 0.06% CO in argon at 4 K. (a) 50 min of sample deposition, (b) after annealing to 30 K, (c) after annealing to 34 K, (d) after 15 min of broad-band irradiation, and (e) after annealing to 38 K.

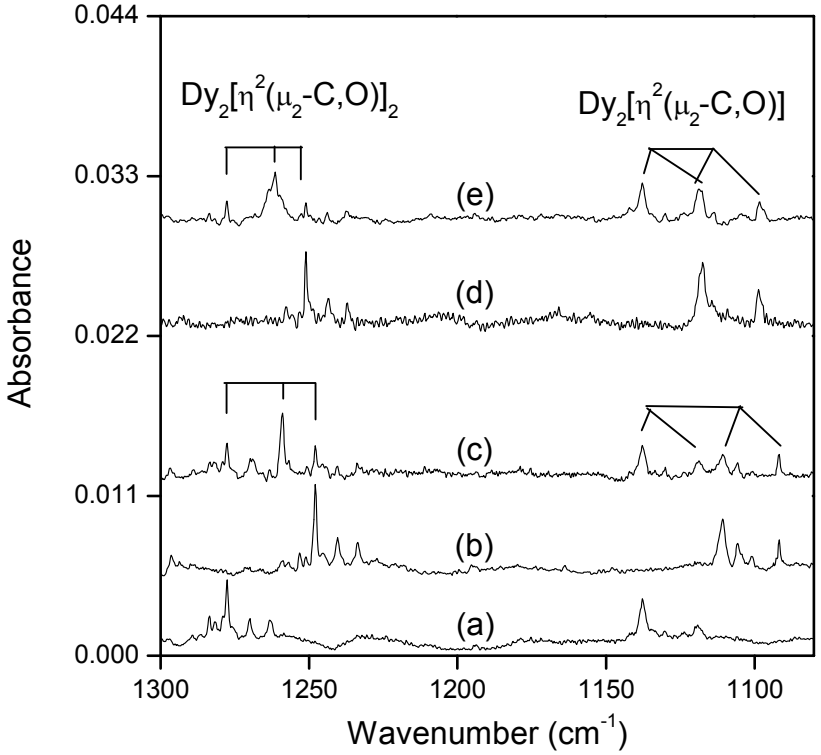

Figure S2. Infrared spectra in the 1300–1100 cm^{-1} region for laser-ablated Dy atoms co-deposited with isotopic CO in Ar for 50 min at 4 K, followed by annealing to 34 K. (a) 0.06% $^{12}C^{16}O$, (b) 0.06% $^{13}C^{16}O$, (c) 0.05% $^{12}C^{16}O$ + 0.05% $^{13}C^{16}O$, (d) 0.06% $^{12}C^{18}O$, and (e) 0.05% $^{12}C^{16}O$ + 0.05% $^{12}C^{18}O$.

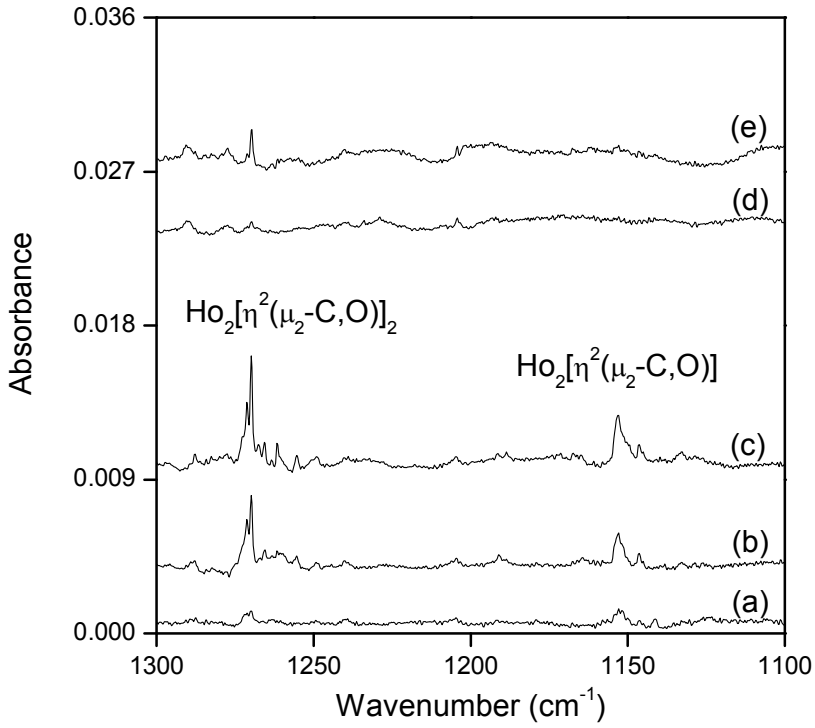

Figure S3. IR spectra in the 1300–1100 cm^{-1} region for laser-ablated Ho atoms co-deposited with 0.1% CO in argon at 4 K. (a) 50 min of sample deposition, (b) after annealing to 30 K, (c) after annealing to 34 K, (d) after 15 min of broad-band irradiation, and (e) after annealing to 38 K.

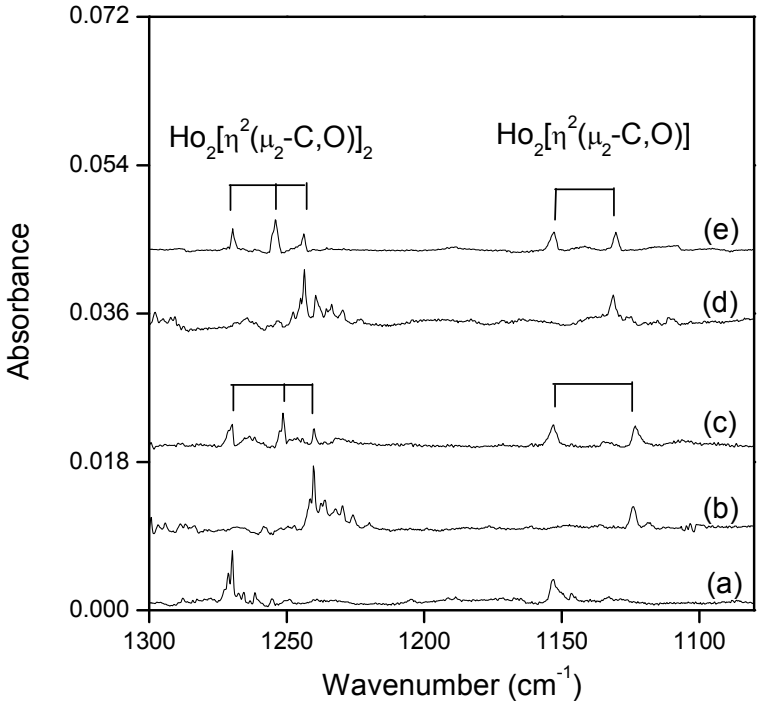

Figure S4. Infrared spectra in the 1300–1100 cm^{-1} region for laser-ablated Ho atoms co-deposited with isotopic CO in Ar for 50 min at 4 K, followed by annealing to 34 K. (a) 0.1% $^{12}C^{16}O$, (b) 0.1% $^{13}C^{16}O$, (c) 0.08% $^{12}C^{16}O$ + 0.08% $^{13}C^{16}O$, (d) 0.1% $^{12}C^{18}O$, and (e) 0.08% $^{12}C^{16}O$ + 0.08% $^{12}C^{18}O$.

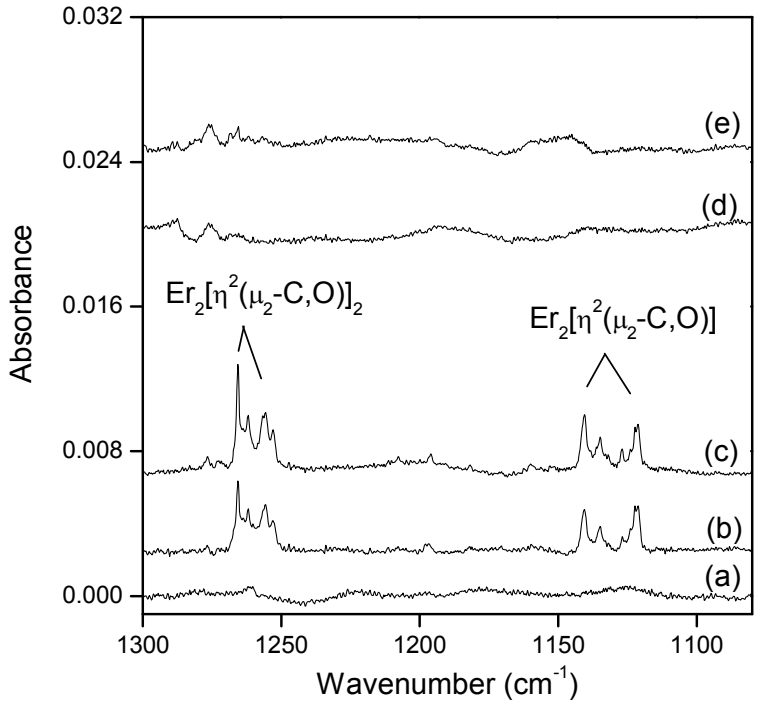

Figure S5. IR spectra in the 1300–1100 cm^{-1} region for laser-ablated Er atoms co-deposited with 0.1% CO in argon at 4 K. (a) 50 min of sample deposition, (b) after annealing to 30 K, (c) after annealing to 34 K, (d) after 15 min of broad-band irradiation, and (e) after annealing to 38 K.

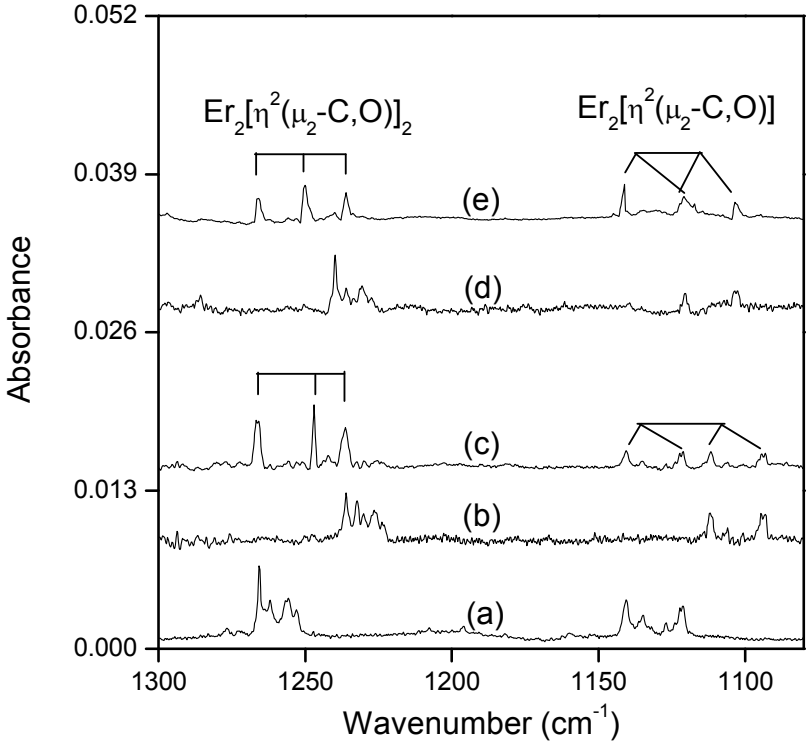

Figure S6. Infrared spectra in the 1300–1100 cm^{-1} region for laser-ablated Er atoms co-deposited with isotopic CO in Ar for 50 min at 4 K, followed by annealing to 34 K. (a) 0.1% $^{12}C^{16}O$, (b) 0.1% $^{13}C^{16}O$, (c) 0.08% $^{12}C^{16}O$ + 0.08% $^{13}C^{16}O$, (d) 0.1% $^{12}C^{18}O$, and (e) 0.08% $^{12}C^{16}O$ + 0.08% $^{12}C^{18}O$.

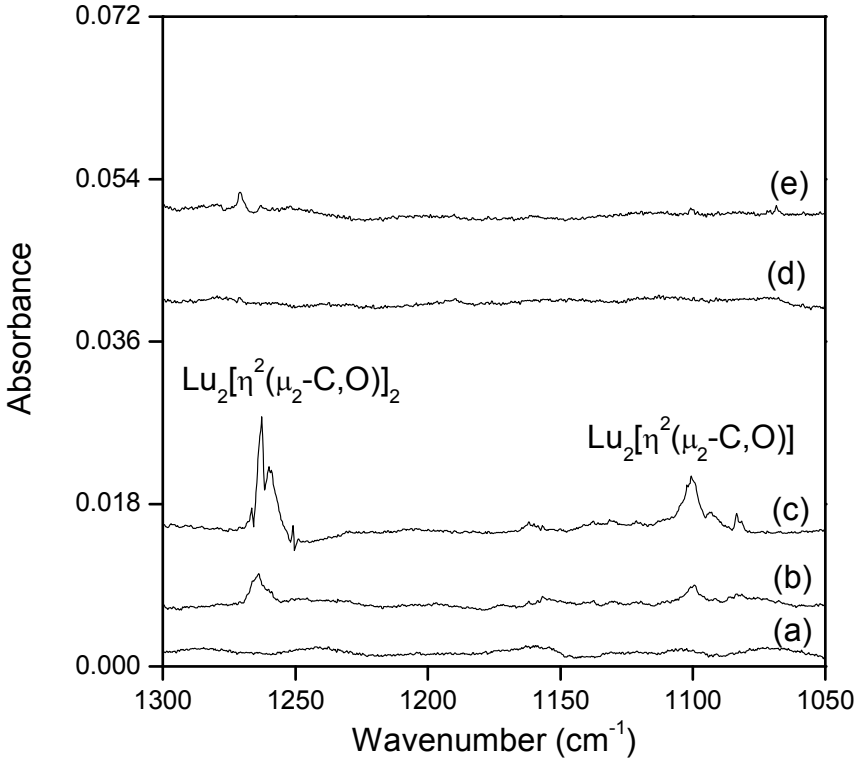

Figure S7. IR spectra in the 1300−1050 cm^{-1} region for laser-ablated Lu atoms co-deposited with 0.15% CO in argon at 4 K. (a) 50 min of sample deposition, (b) after annealing to 30 K, (c) after annealing to 34 K, (d) after 15 min of broad-band irradiation, and (e) after annealing to 38 K.

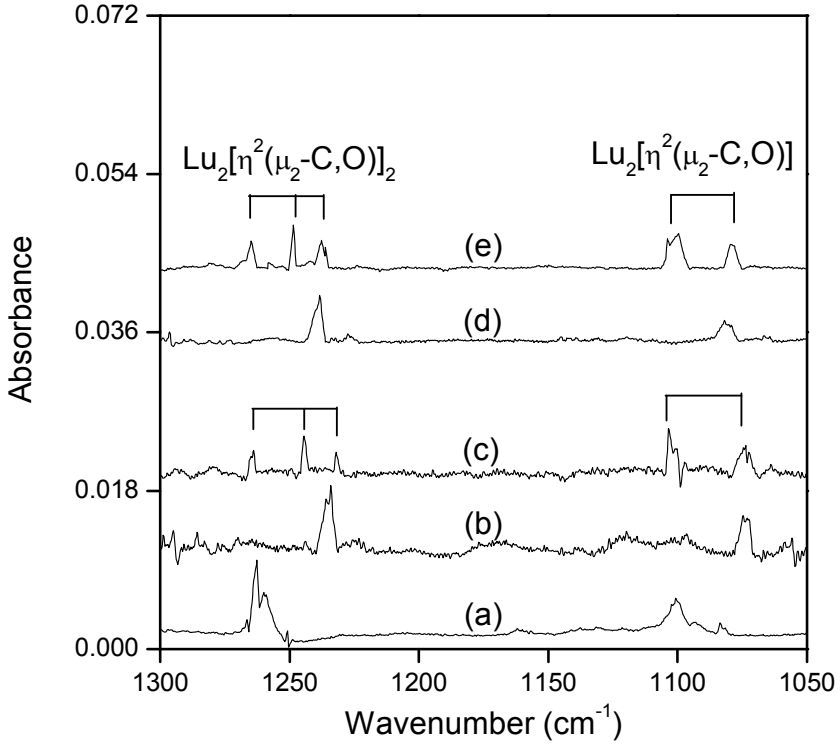

Figure S8. Infrared spectra in the 1300–1050 cm^{-1} region for laser-ablated Lu atoms co-deposited with isotopic CO in Ar for 50 min at 4 K, followed by annealing to 34 K. (a) 0.15% $^{12}C^{16}O$, (b) 0.15% $^{13}C^{16}O$, (c) 0.1% $^{12}C^{16}O$ + 0.1% $^{13}C^{16}O$, (d) 0.15% $^{12}C^{18}O$, and (e) 0.1% $^{12}C^{16}O$ + 0.1% $^{12}C^{18}O$.