Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Nucleation-dependant Chemical Bonding Paradigm: Effect of Rare Earth Ions on the Nucleation of Urea in Aqueous Solution

Xiaoyan Chen,[a,b] Congting Sun,[a] Sixin Wu,*[,b] and Dongfeng Xue*[,a]

[a]*State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun 130022, China*

[b]*The Key Laboratory for Special Functional Materials of MOE, Henan University, Kaifeng, Henan 475004, China*

*Corresponding author. E-mail: dongfeng@ciac.ac.cn

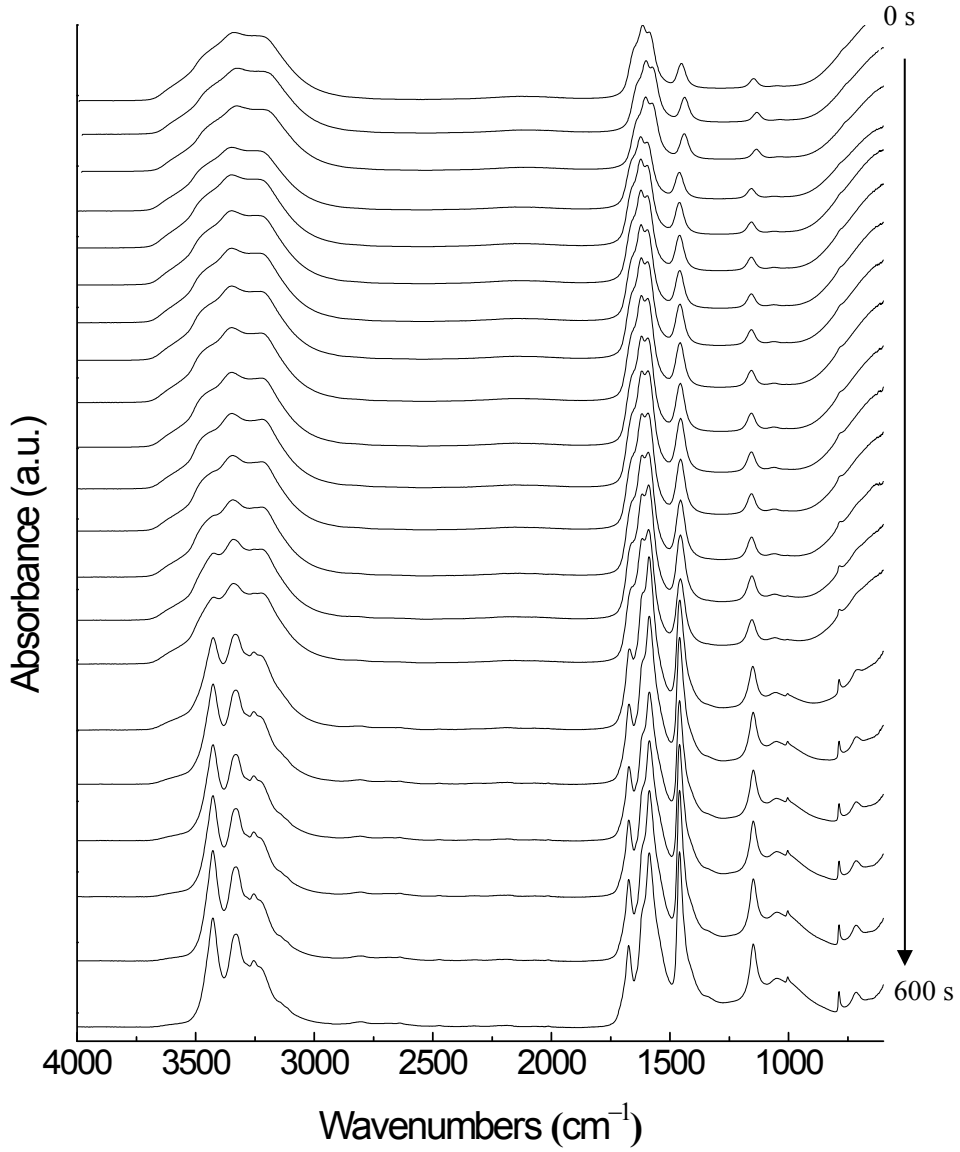

Figure S1. Time-dependent ATR-IR spectra of urea crystallization process at 20 °C. The time interval is 30 s, and the concentration of urea is 6.66 mol/L.

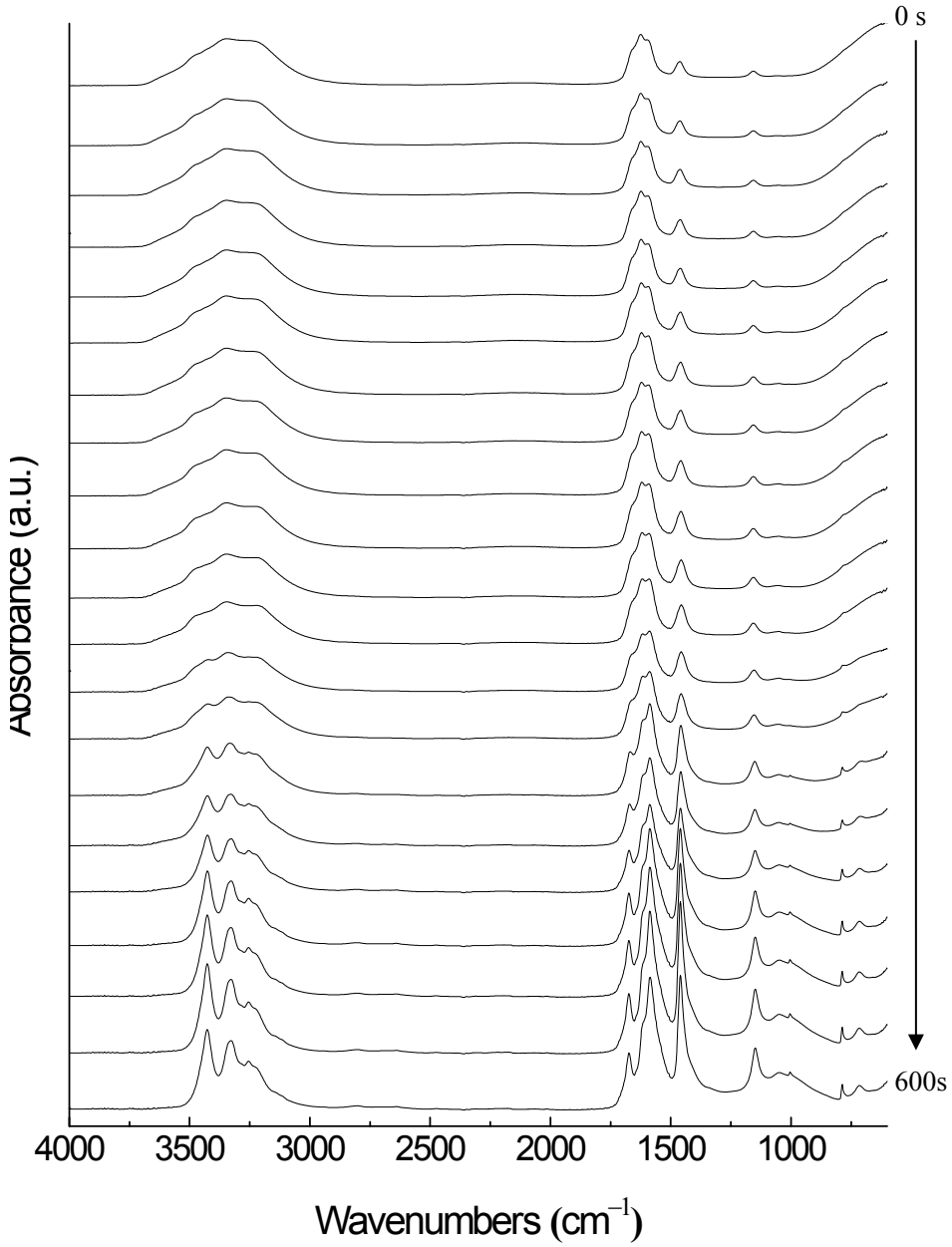

Figure S2. Time-dependent IR spectra of urea crystallization process in urea+$LaCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $LaCl_3$ is 0.077 mol/L.

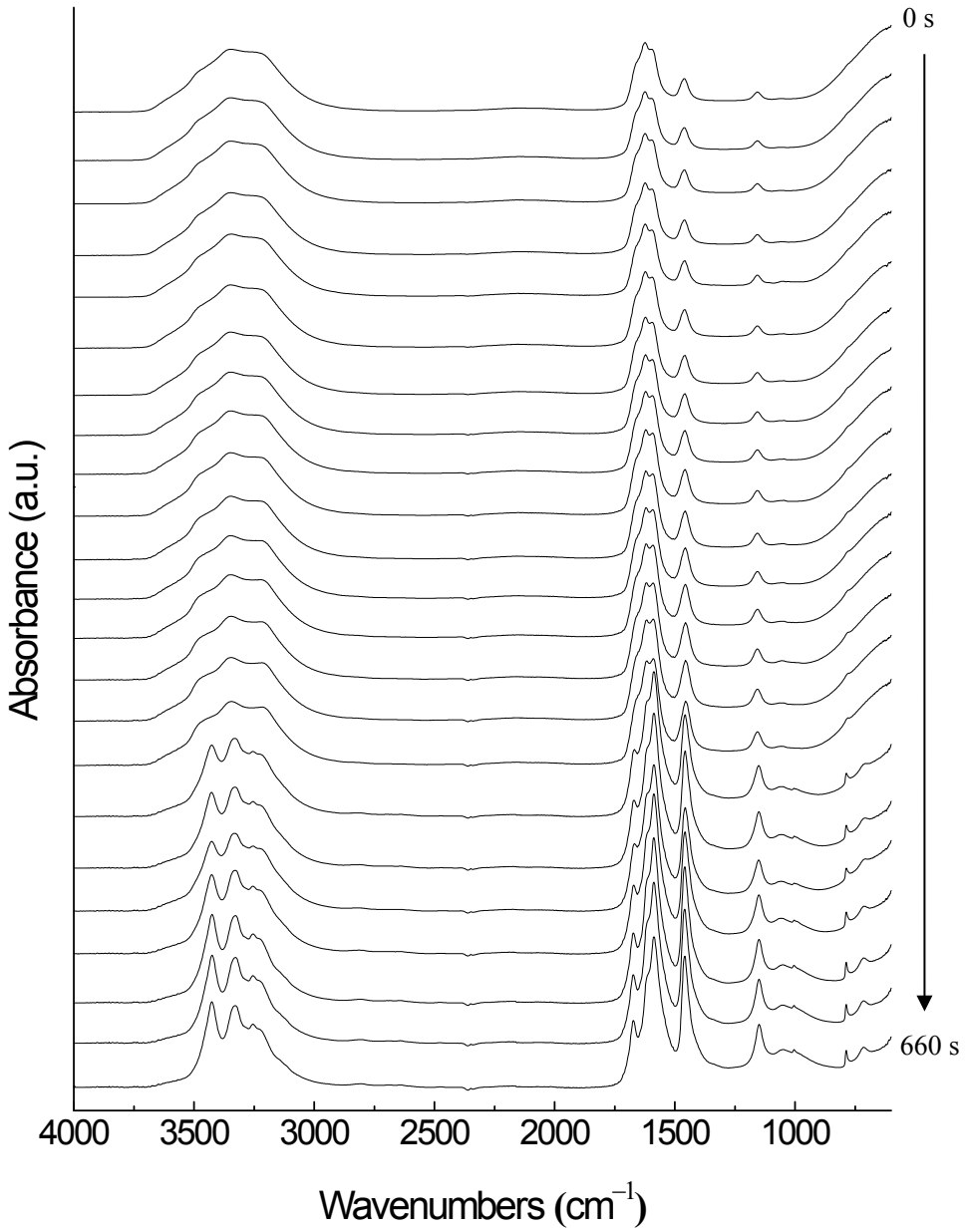

Figure S3. Time-dependent IR spectra of urea crystallization process in urea+$GdCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $GdCl_3$ is 0.077 mol/L.

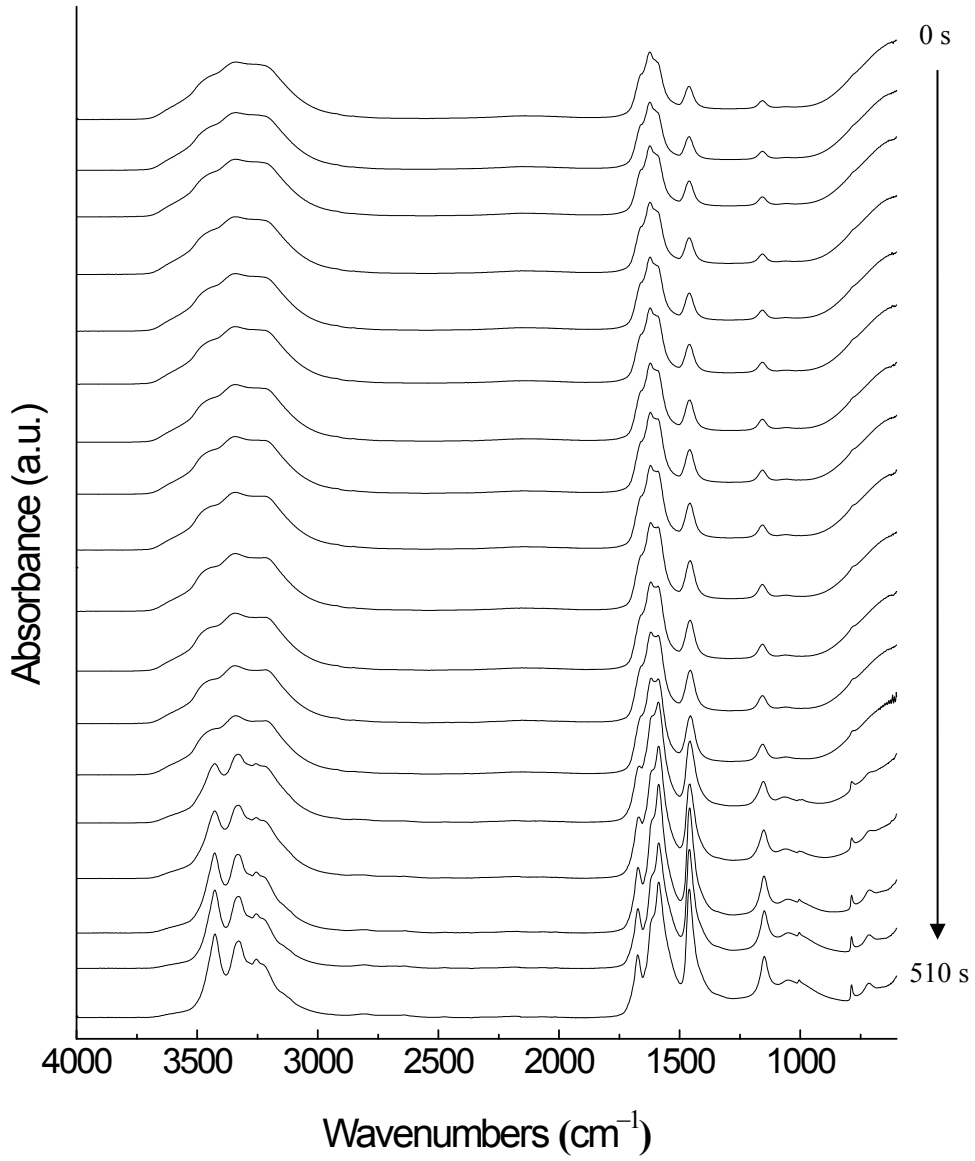

Figure S4. Time-dependent IR spectra of urea crystallization process in urea+$LuCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $LuCl_3$ is 0.077 mol/L.

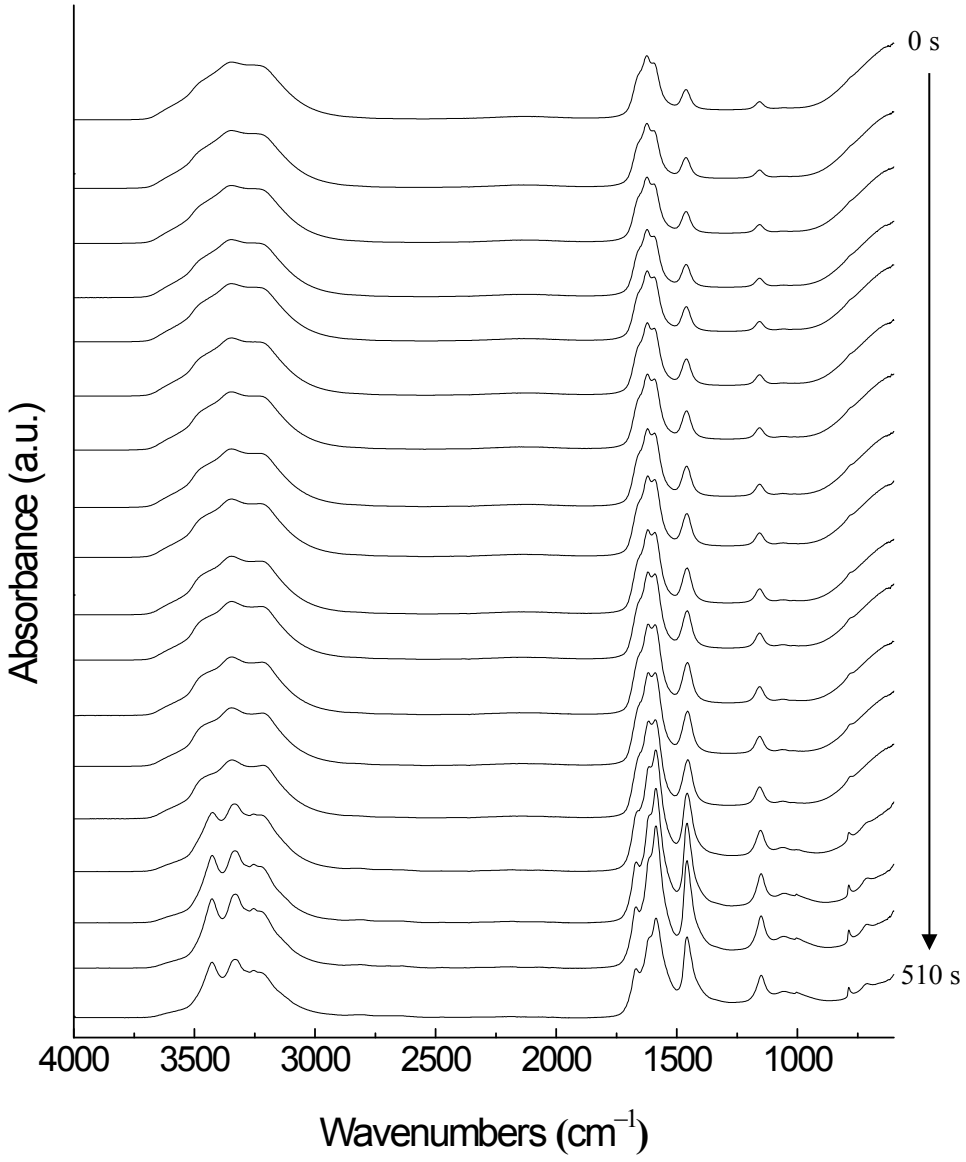

Figure S5. Time-dependent IR spectra of urea crystallization process in urea+$LaCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $LaCl_3$ is 0.155 mol/L.

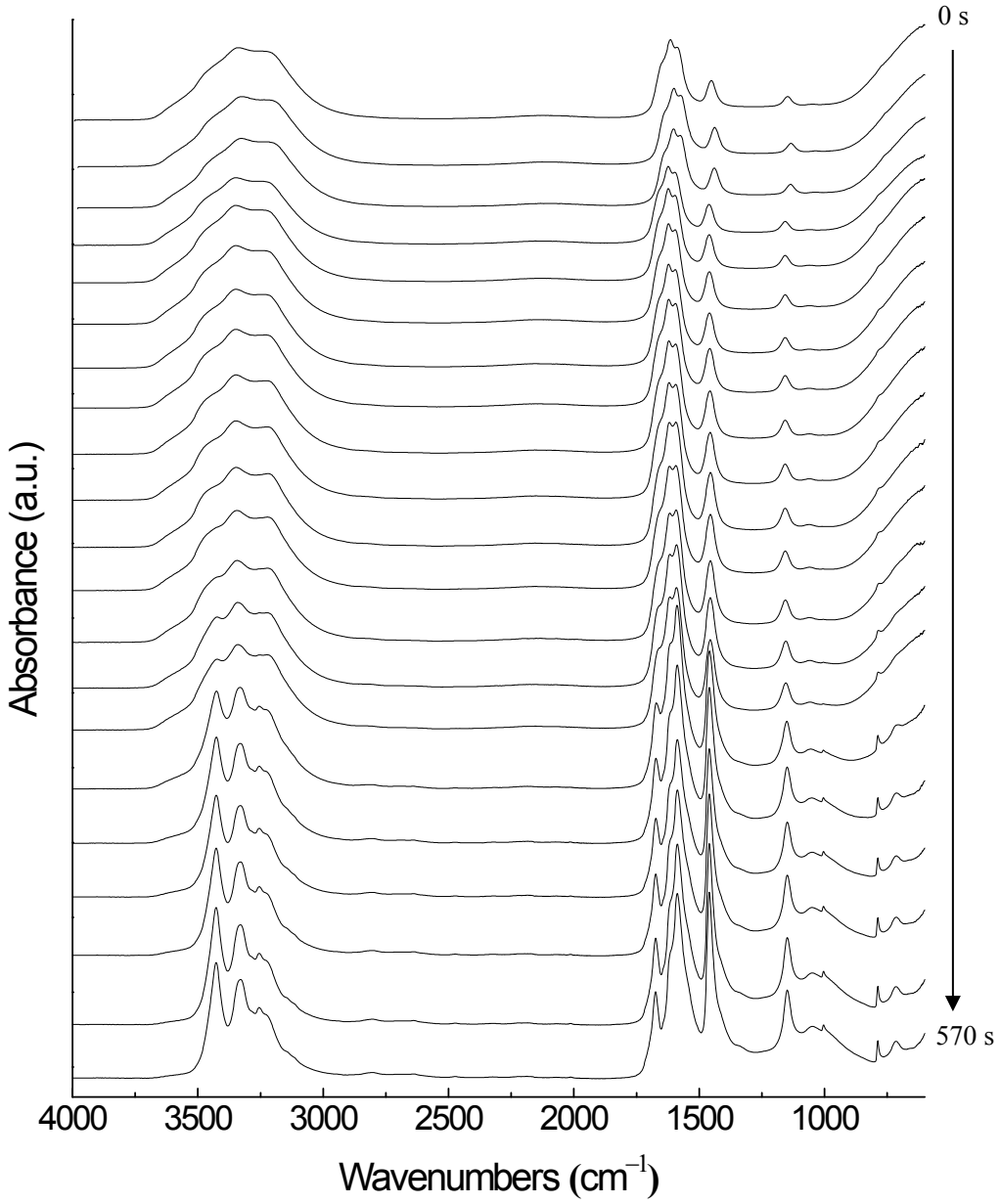

Figure S6. Time-dependent IR spectra of urea crystallization process in urea+$GdCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $GdCl_3$ is 0.155 mol/L.

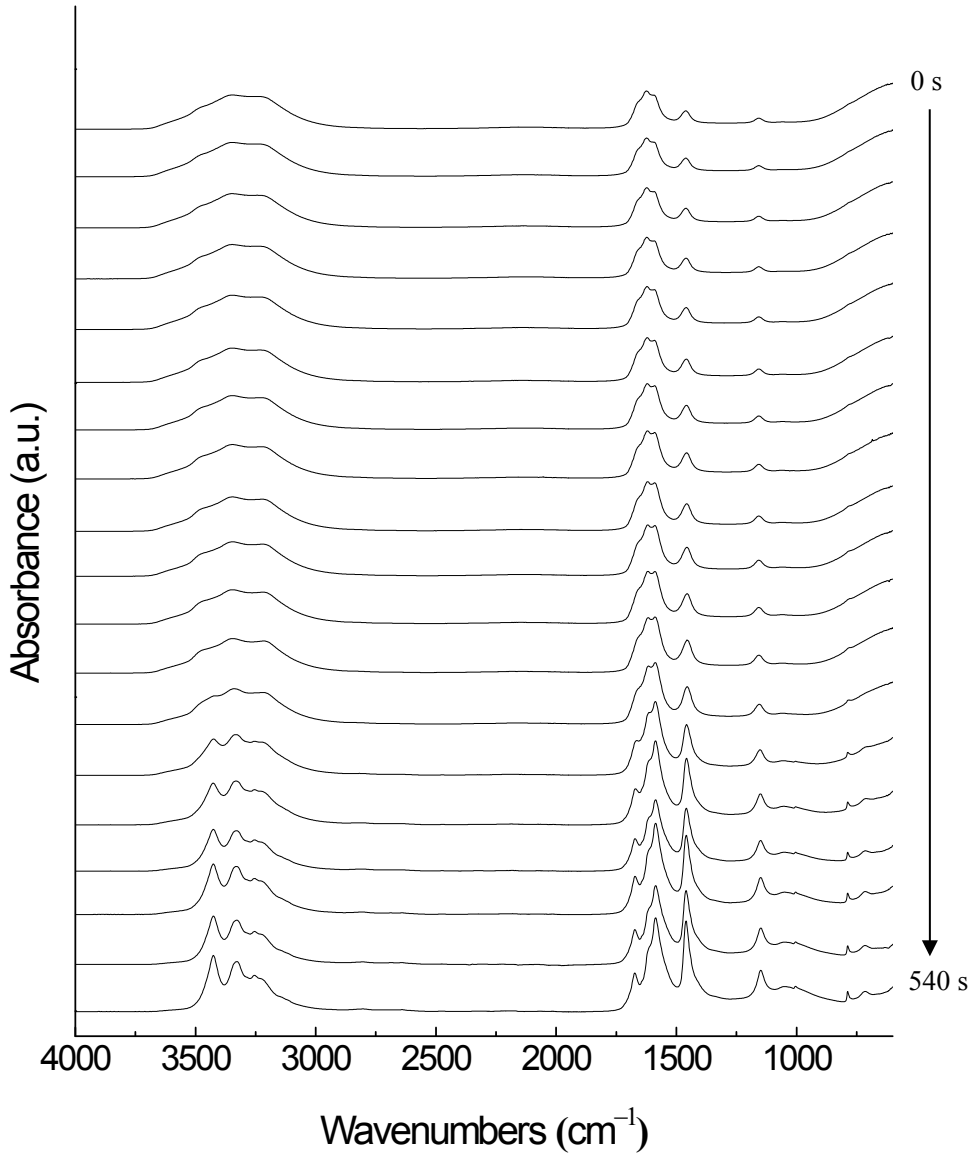

Figure S7. Time-dependent IR spectra of urea crystallization process in urea+$LuCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $LuCl_3$ is 0.155 mol/L.

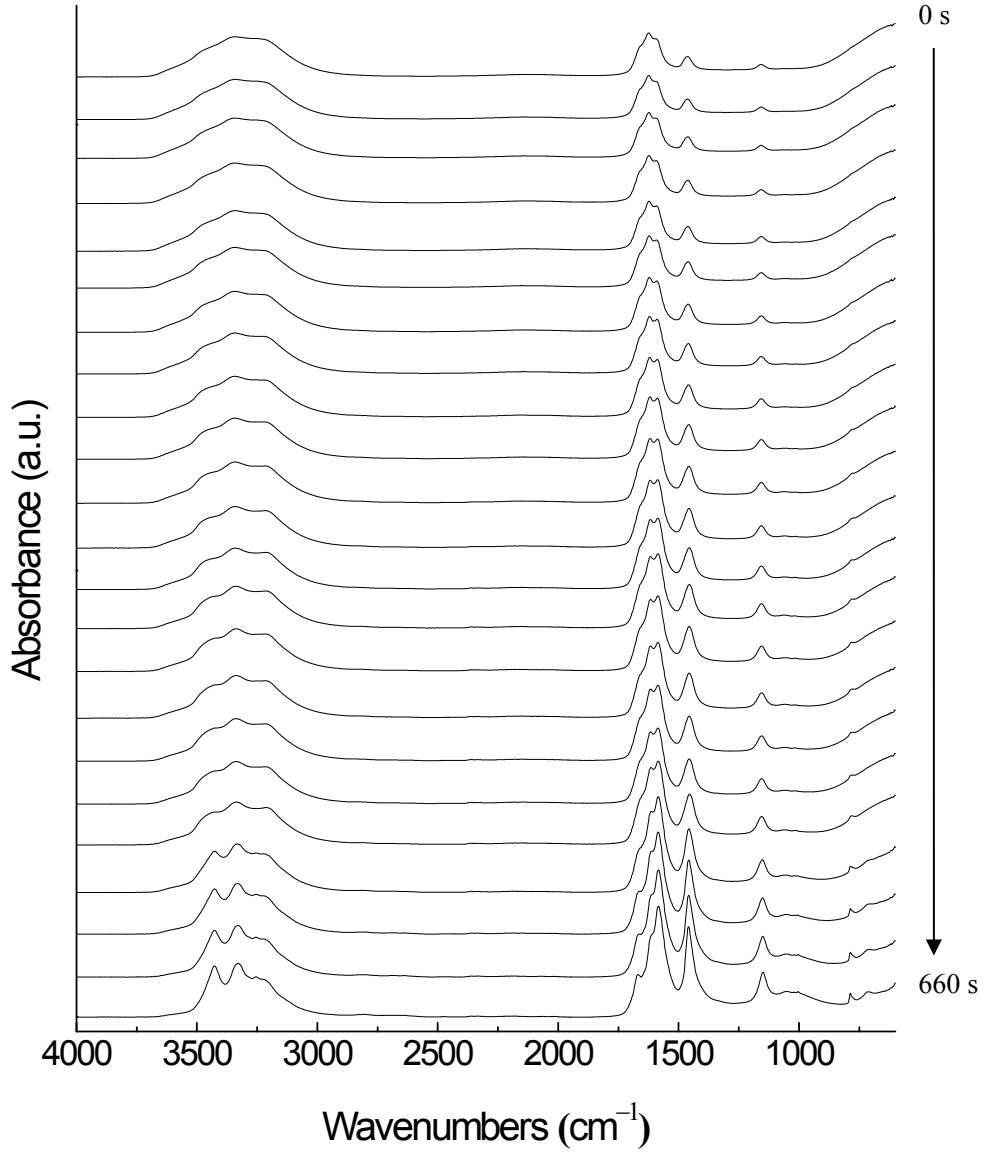

Figure S8. Time-dependent IR spectra of urea crystallization process in urea+$LaCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $LaCl_3$ is 0.310 mol/L.

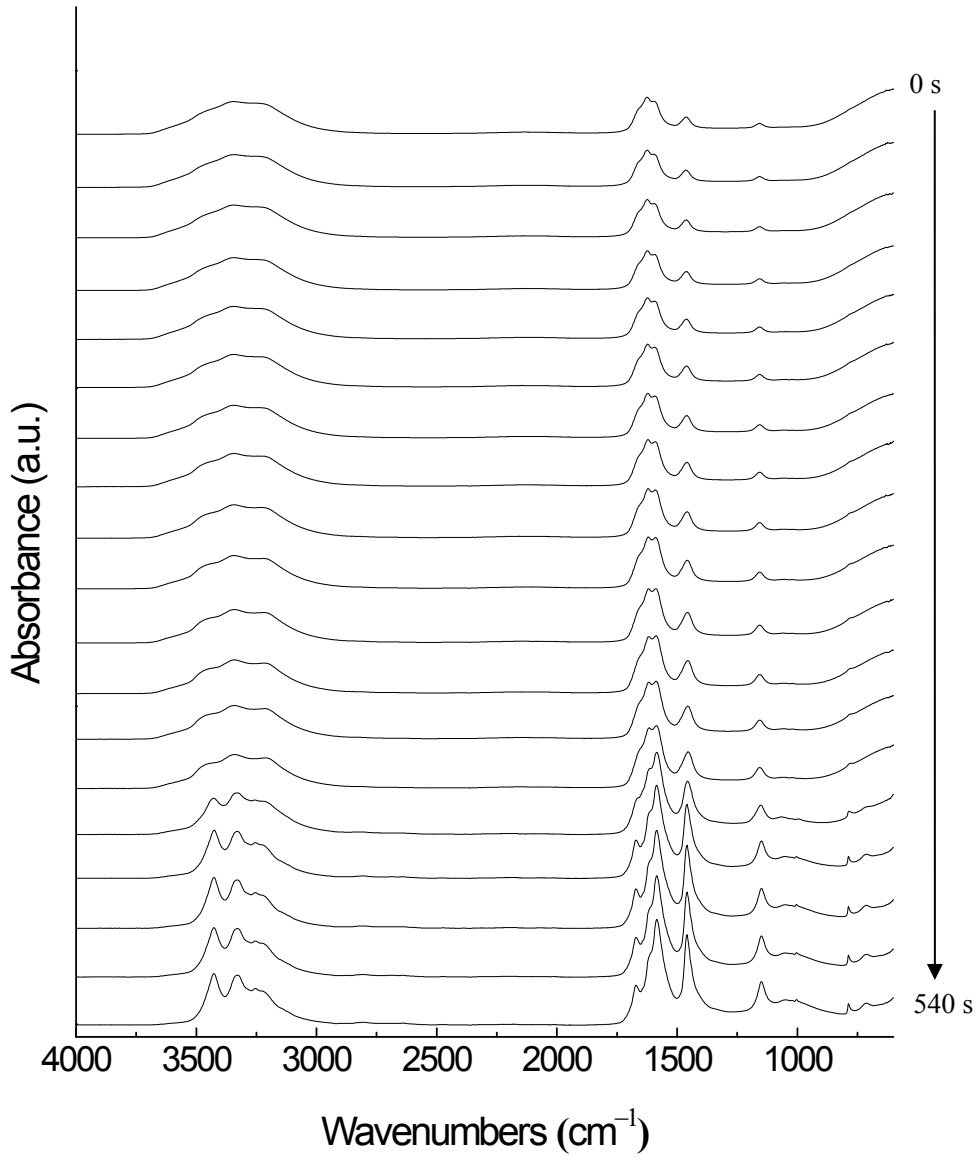

Figure S9. Time-dependent IR spectra of urea crystallization process in urea+$GdCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $GdCl_3$ is 0.310 mol/L.

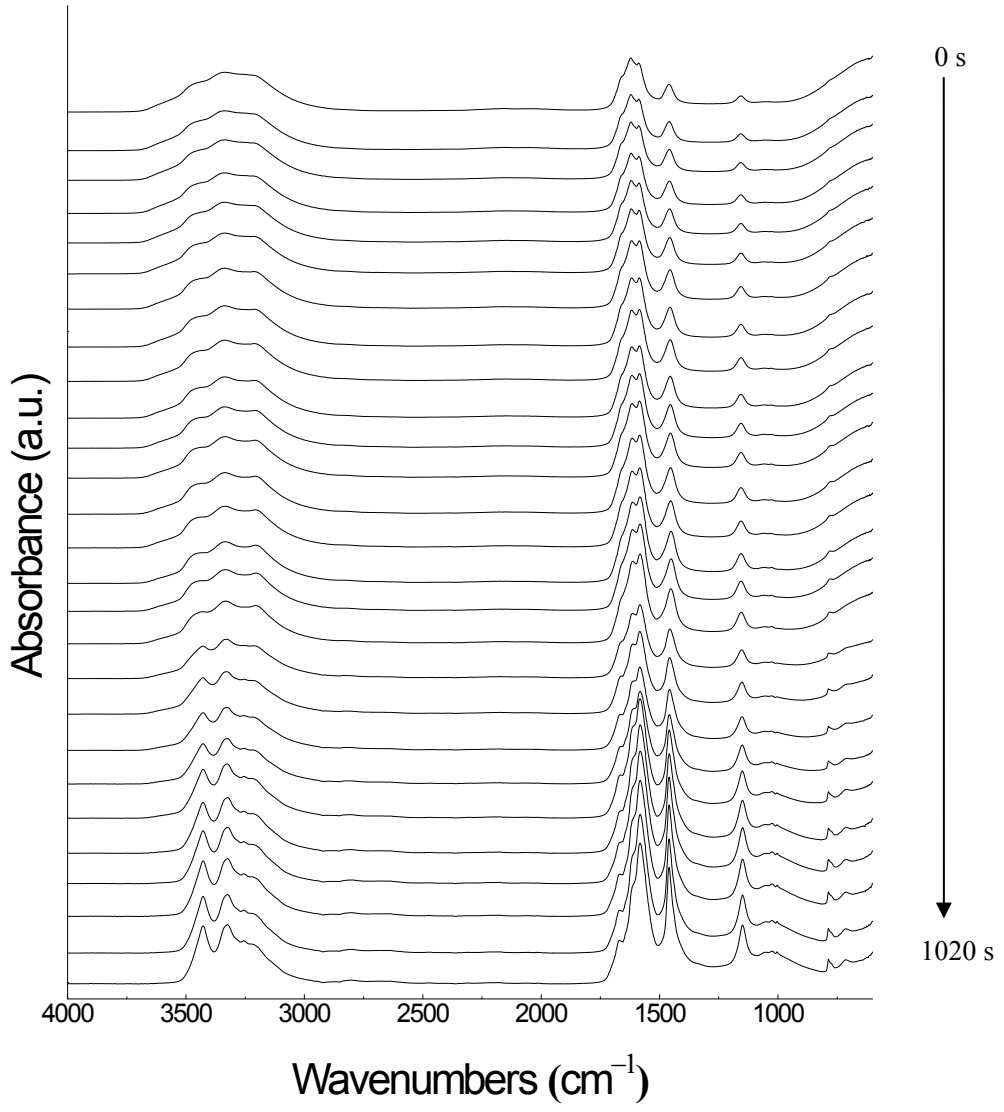

Figure S10. Time-dependent IR spectra of urea crystallization process in urea+$LuCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $LuCl_3$ is 0.310 mol/L.

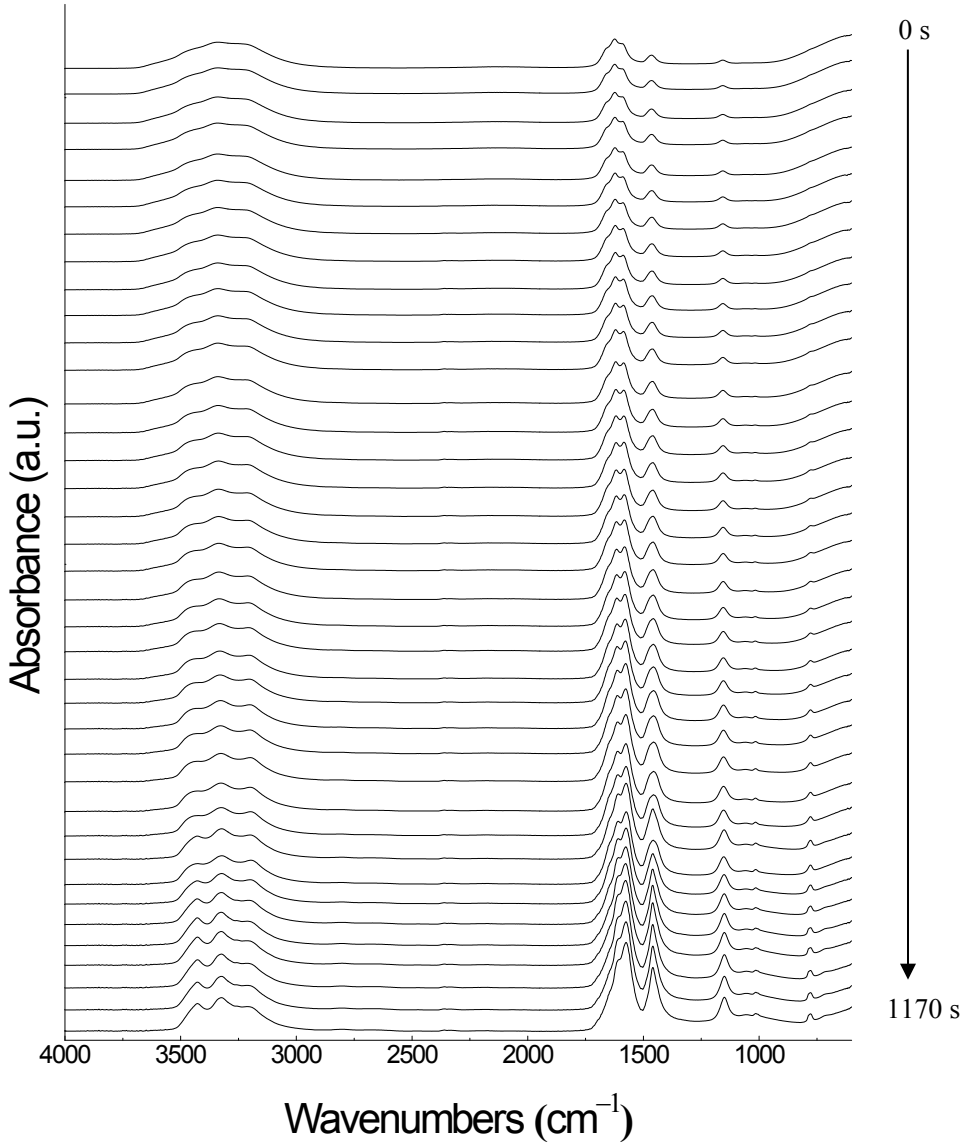

Figure S11. Time-dependent IR spectra of urea crystallization process in urea+$LaCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $LaCl_3$ is 0.615 mol/L.

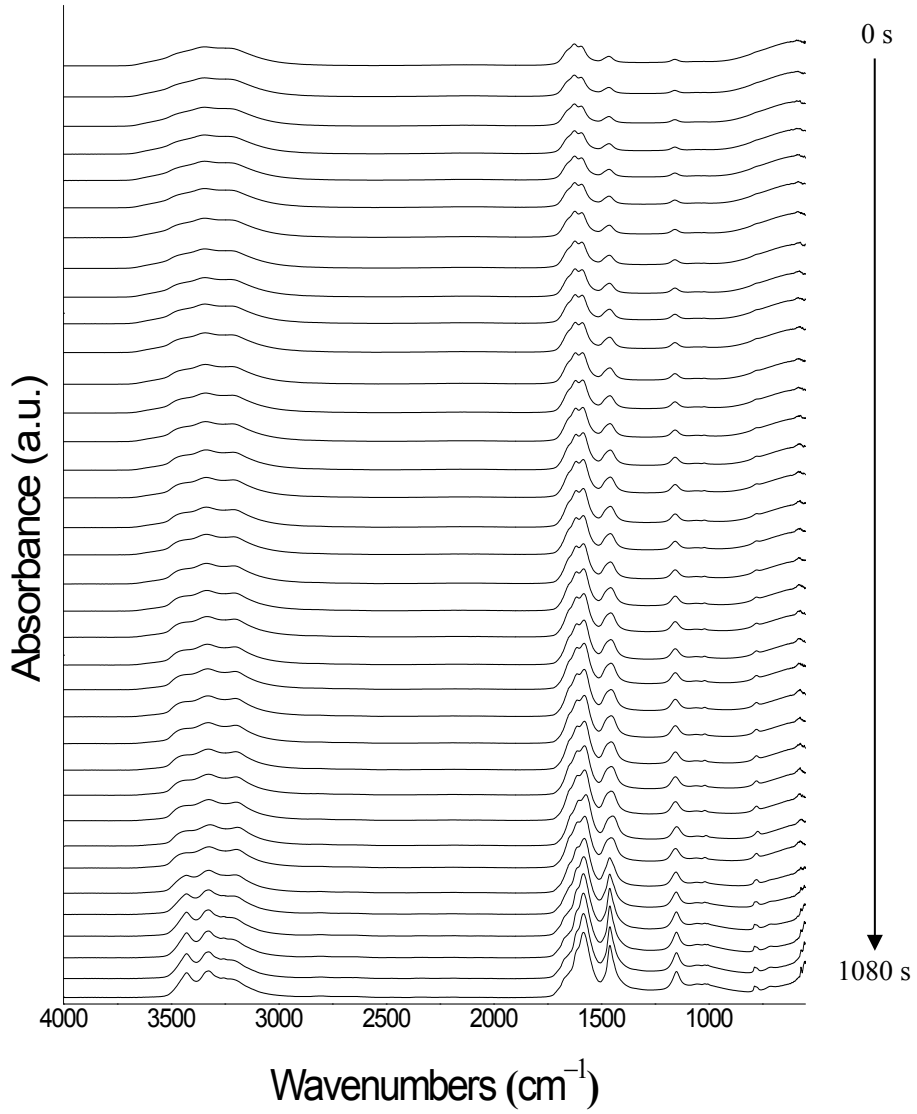

Figure S12. Time-dependent IR spectra of urea crystallization process in urea+$GdCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $GdCl_3$ is 0.615 mol/L.

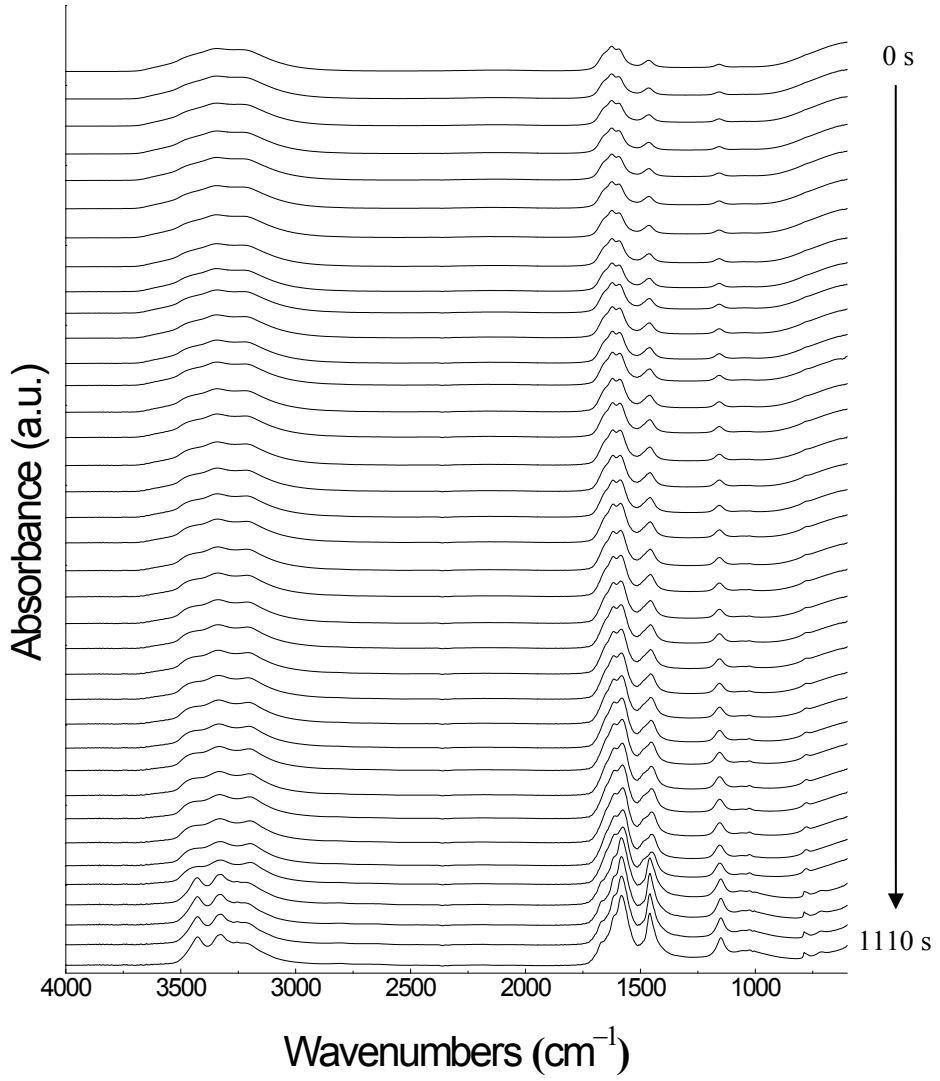

Figure S13. Time-dependent IR spectra of urea crystallization process in urea+$LuCl_3$ aqueous solution. The time interval is 30 s, and the concentration of $LuCl_3$ is 0.615 mol/L.

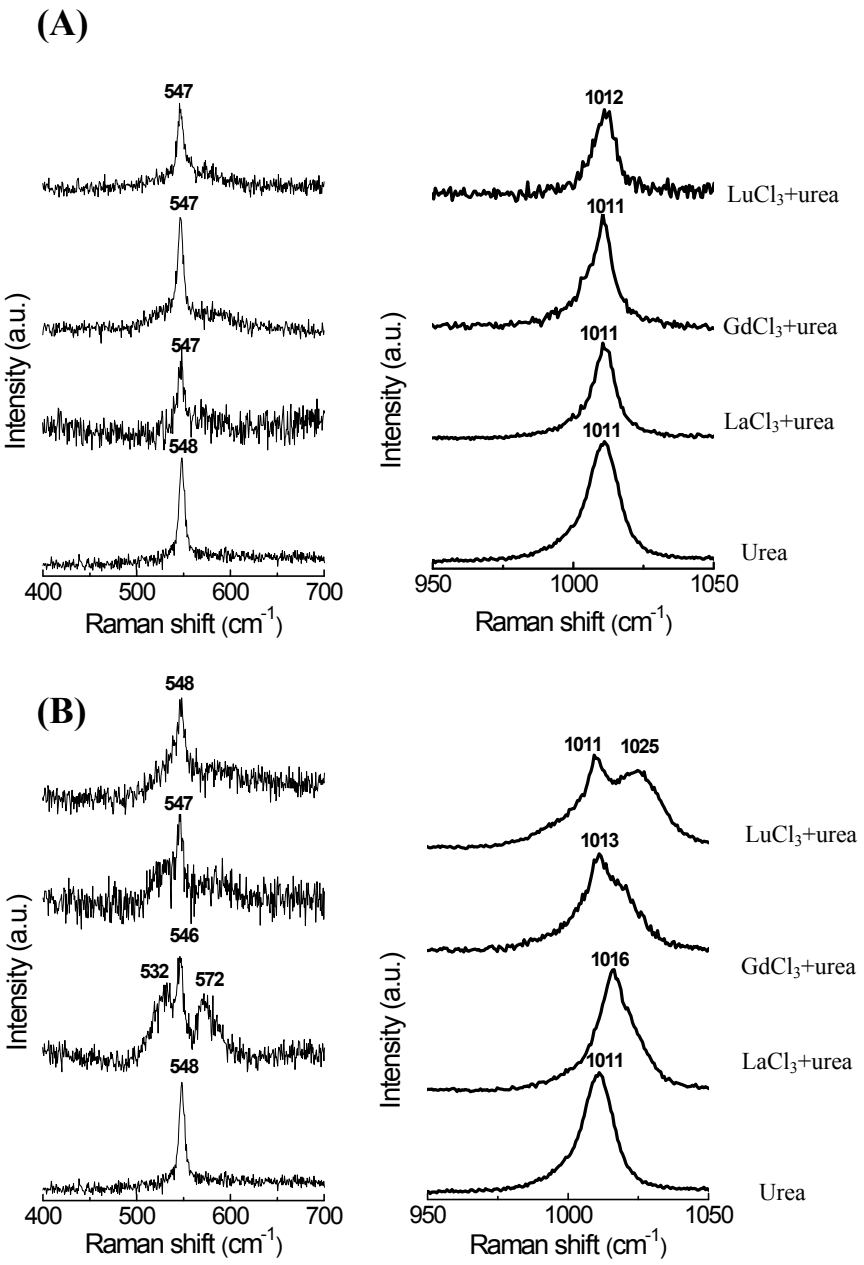

Figure S14. Raman spectra of NCN stretching vibrations in crystalline urea from urea/$LnCl_3$ aqueous solutions, and concentration of $LnCl_3$ are 0.077 mol/L(A) and 0.615 mol/L (B).