Supporting Information

Role of Membrane Technology in Biorefineries - Dehydration of Deep Eutectic Solvent by Pervaporation

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NMR spectra of PDMS and PDMS-PVA-TiO_2

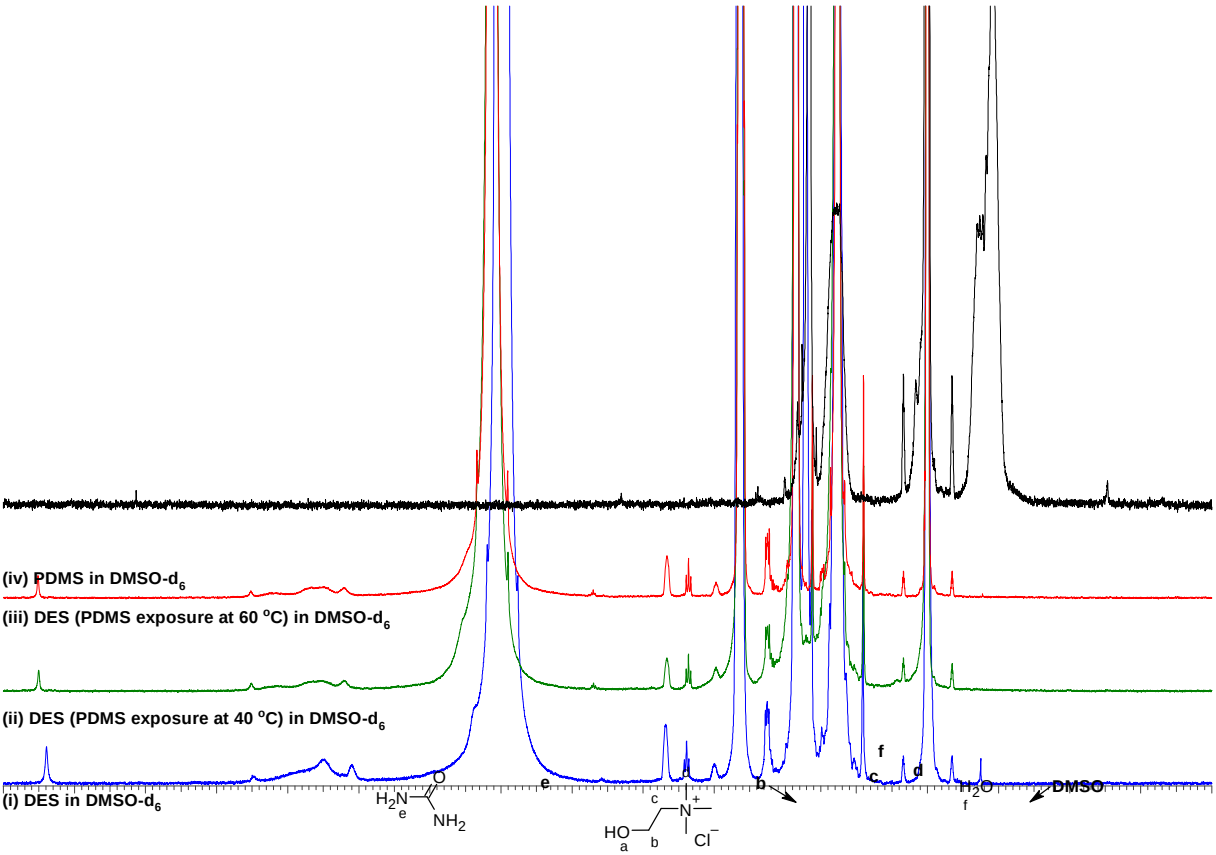

Figure A.1. ^{1}H NMR spectra of fresh DES (i), exposed DES samples (ii and iii), and PDMS (iv) in DMSO-d_6.

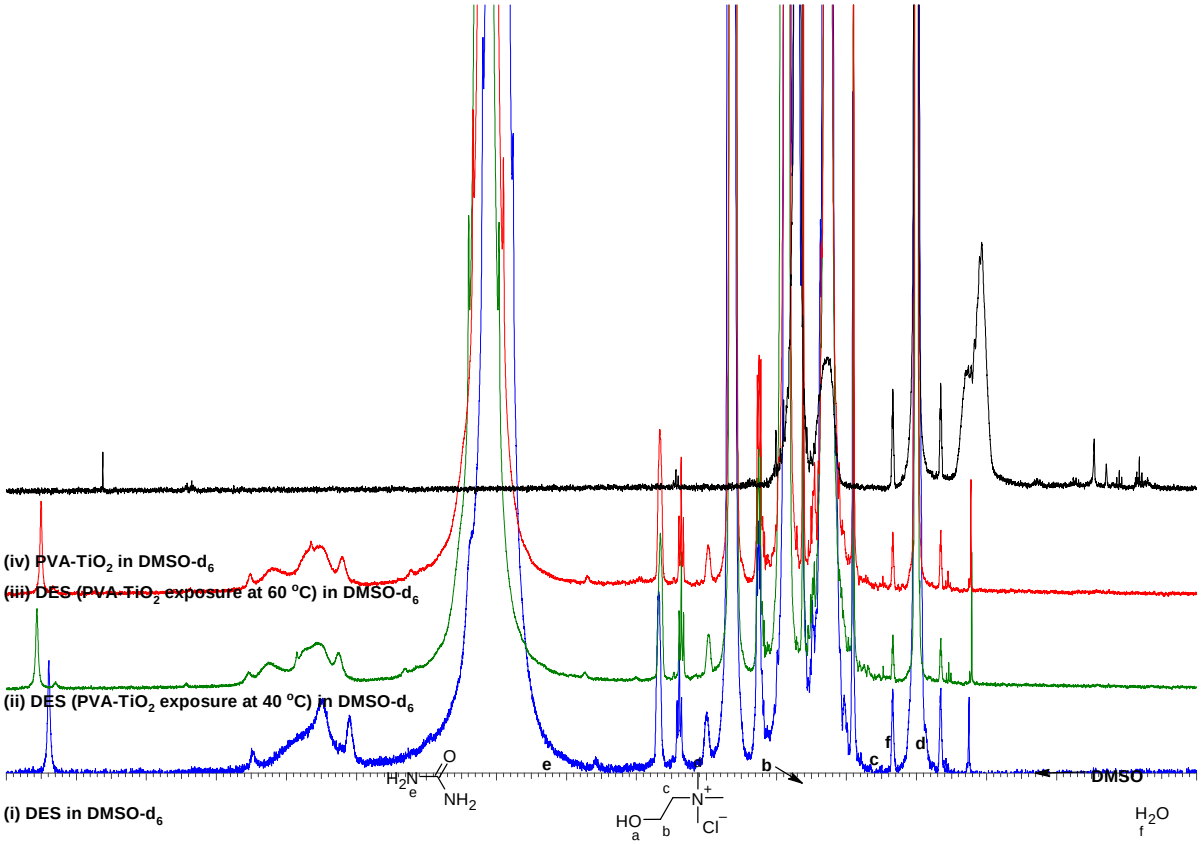

Figure A.2. ^{1}H NMR spectra of fresh DES (i), exposed DES samples (ii and iii), and PDMS-PVA-TiO_2 (iv) in DMSO-d_6.

Field Emission Scanning Electron Microscopy (FESEM)

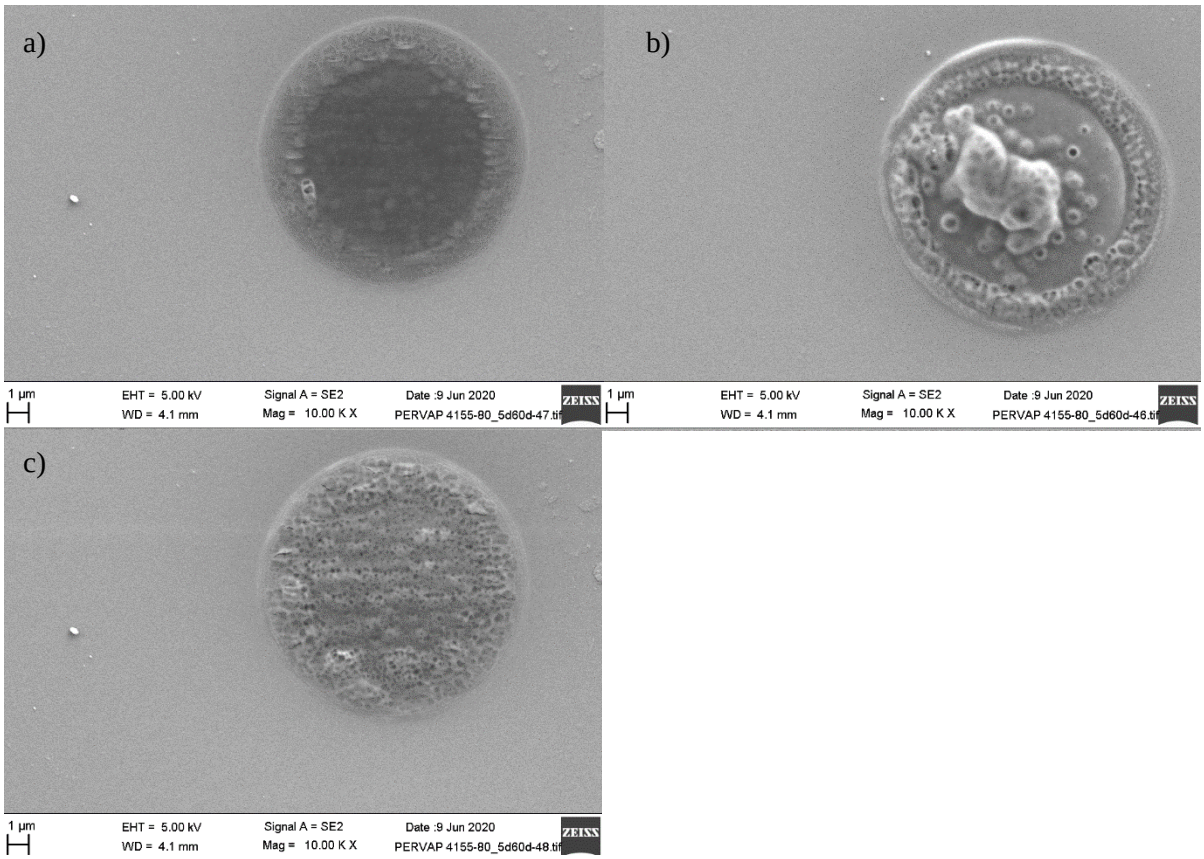

Figure A.3. FESEM images of a location with ChCl-urea inside the membrane structure and bubbling with 10,000 x magnification. The images were taken in series; first a) and as last c). The bubbling of ChCl-urea may have been caused by the higher intensity of the several electron beam scans as the scanning focus is on a relatively small surface area when high magnifications are used; and in addition, by vacuum in the sample compartment.

FIB-SEM images

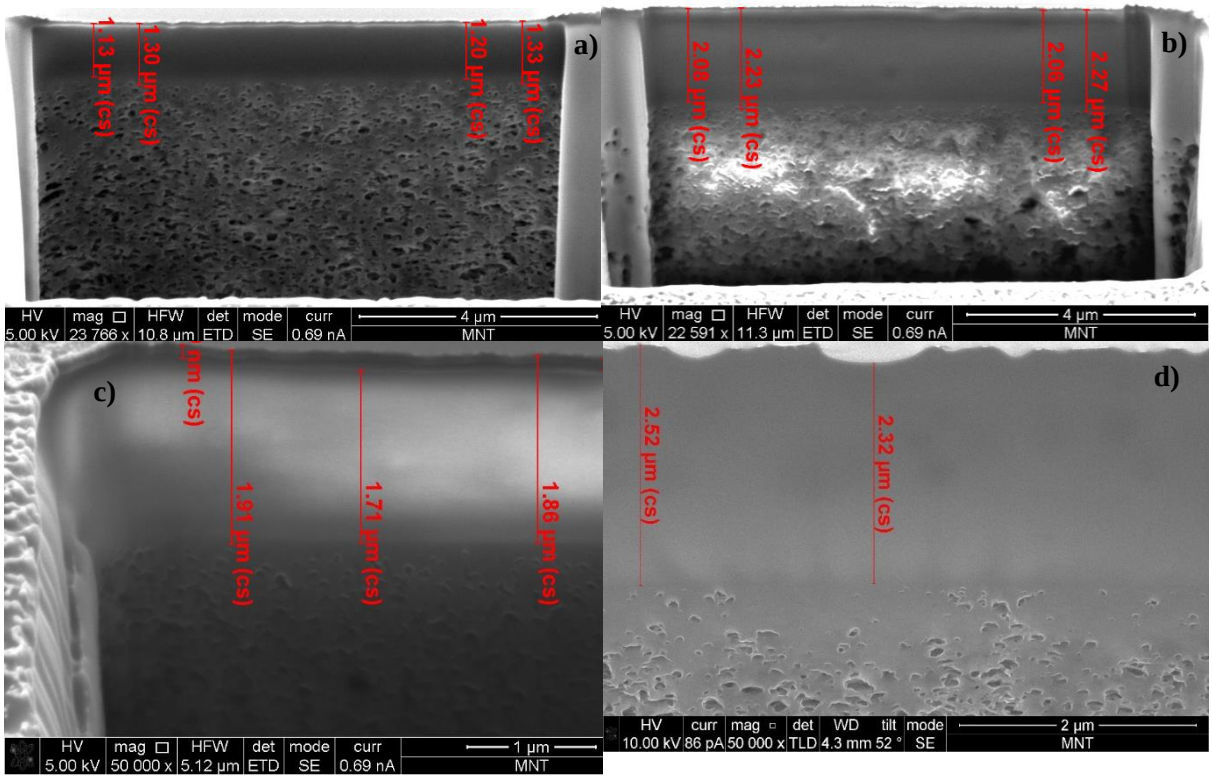

Figure A.4. FIB-SEM images of PERVAP 4155-80 membrane: a) fresh, b) exposed at 40 °C, c) exposed at 60 °C, and d) used in dehydration of ChCl-urea.

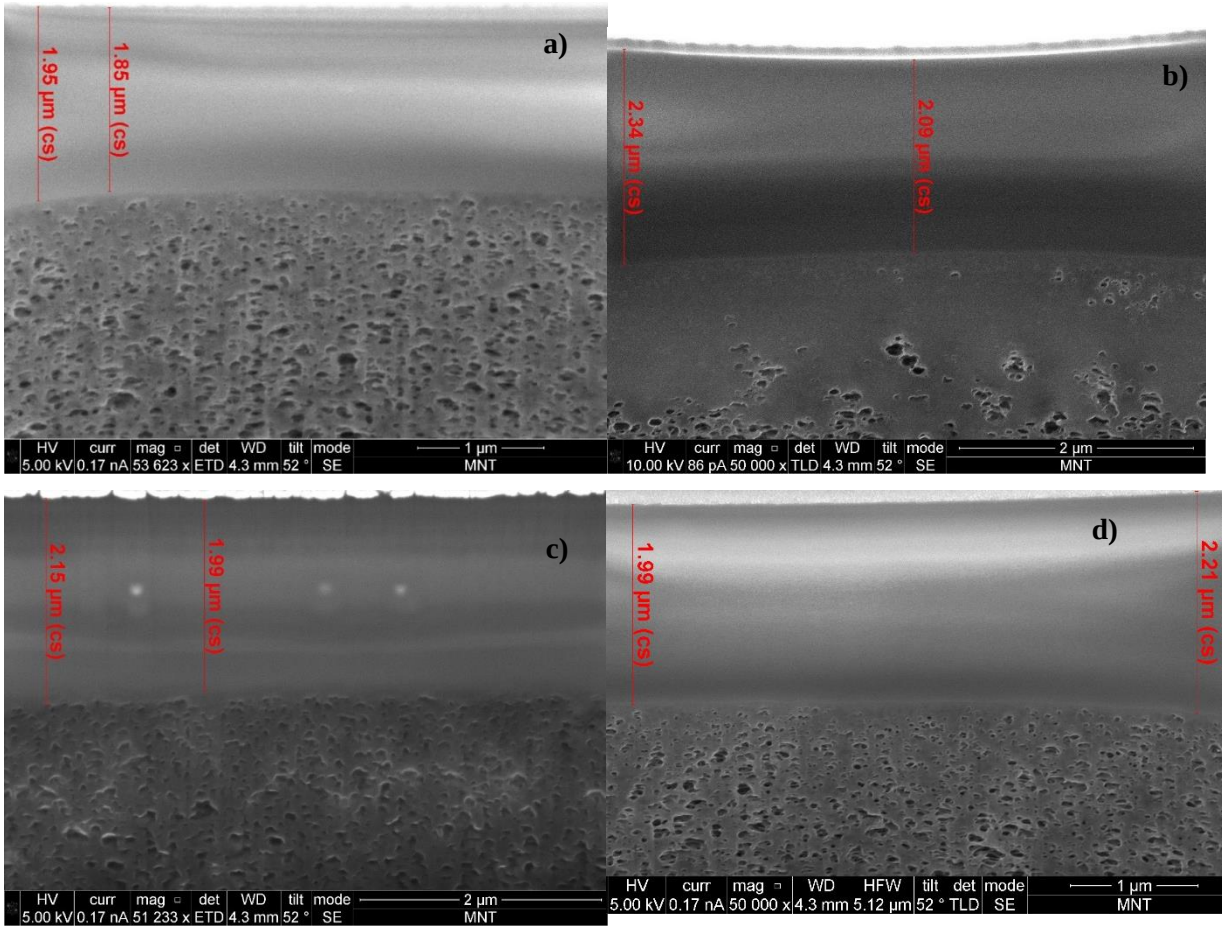

Figure A.5. FIB-SEM images of PDMS membrane: a) fresh, b) exposed at 40 °C, c) exposed at 60 °C, and d) used in dehydration of ChCl-urea.

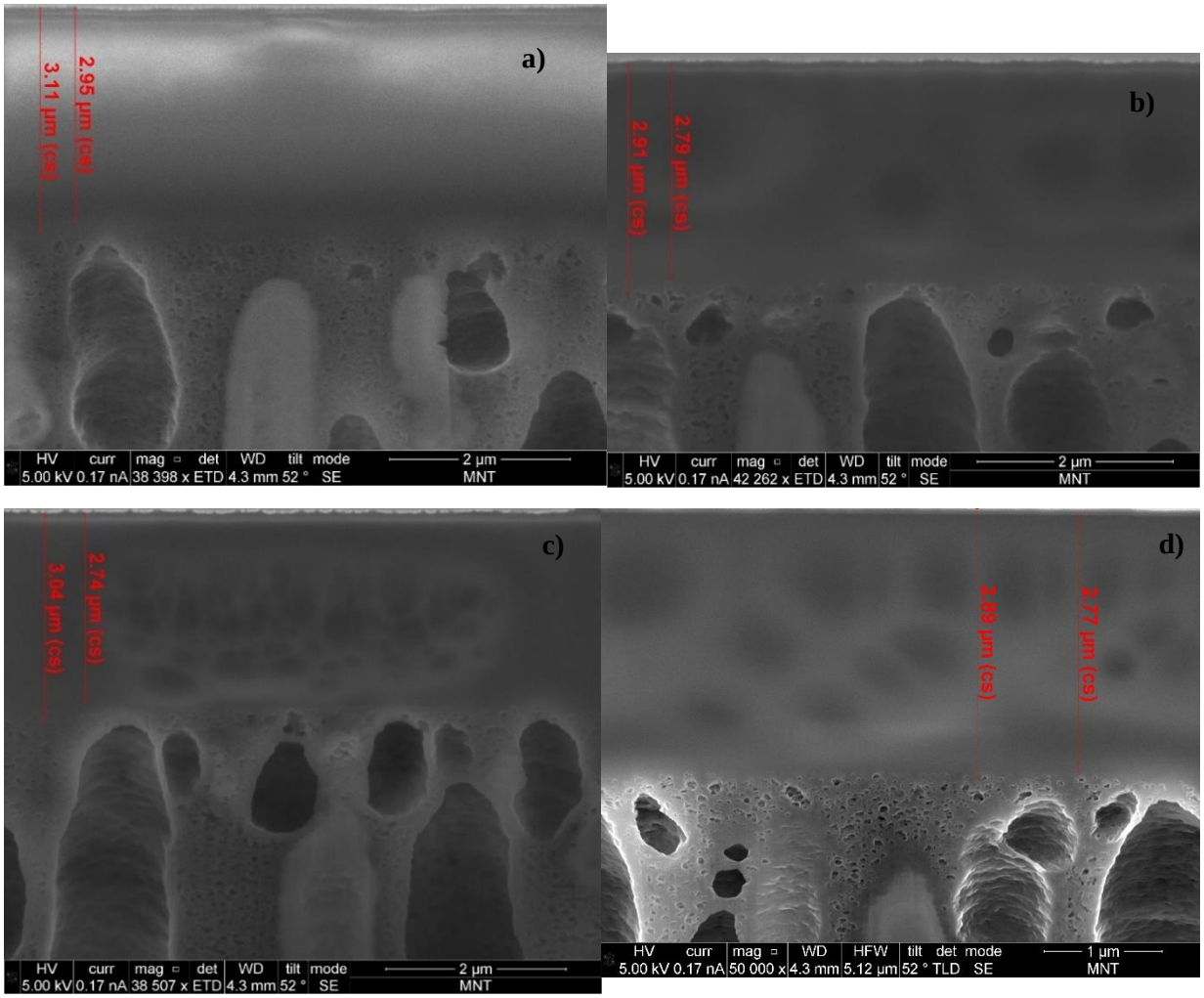

Figure A.6. FIB-SEM images of PDMS-PVA-TiO_2 membrane: a) fresh, b) exposed at 40 °C, c) exposed at 60 °C, and d) used in dehydration of ChCl-urea.

Raman spectroscopy

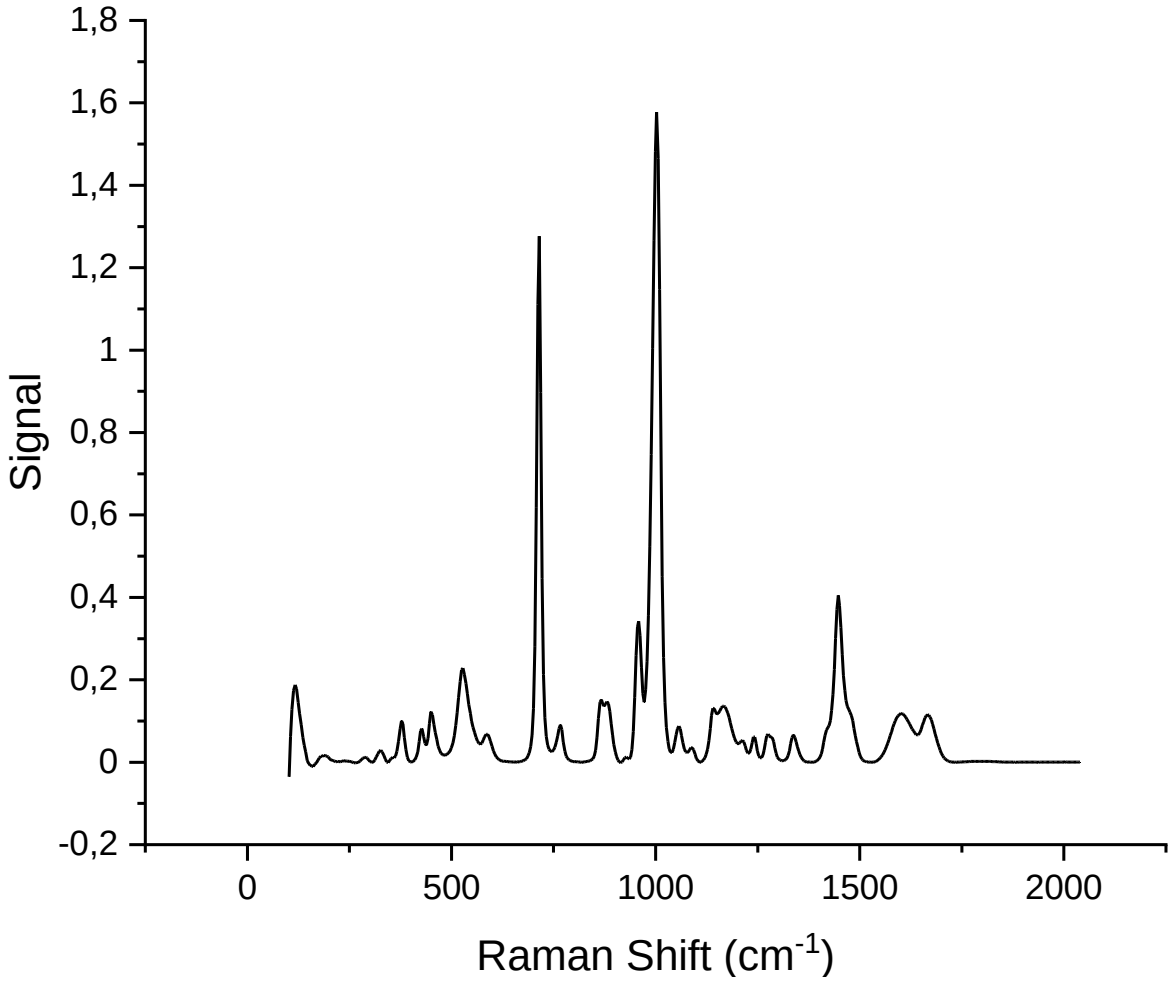

Figure A.7. Raman spectrum of 90% ChCl-urea feed solution.

Table A.1. Assignments of the Raman bands of ChCl-urea.

Raman shift [cm^{-1}]	**Assignment**	**Ref.**
528.01	CN_2 scissors of urea *(δ NCN)*	[1,2]
714.97	Symmetric stretching vibration of the four C–N bonds of the *gauche* conformation of choline (ν_{s1}*CN gauche*)	[1–4]
766.88	Symmetric stretching vibration of *trans* conformation of choline (ν_{s1} *CN*)	[1,4]
866.95	Symmetric C–N stretching vibration of choline *(ν_{s2} CN)*	[1,5]
880.77	C–H rocking vibration of choline (ρ *CH_2*)	[1]
958.67	C–H rocking vibration of choline (ρ *CH_3*)	[4]
1002.51	Symmetric CN stretching vibrations (ν_{sym} *CN*) of urea	[1–3]
1447.30	Wagging C–H vibration of choline *(ω CH)*	[2,4]
1600.09	CO stretching vibrations *(ν CO)**	[3]
1666.01	Antisymmetric and symmetric CN stretching vibrations (ν_{as} *CN* & ν_s *CN*)*	[3]

* These broad bands may be the result of the formation of hydrogen bonds between ChCl and urea [3].

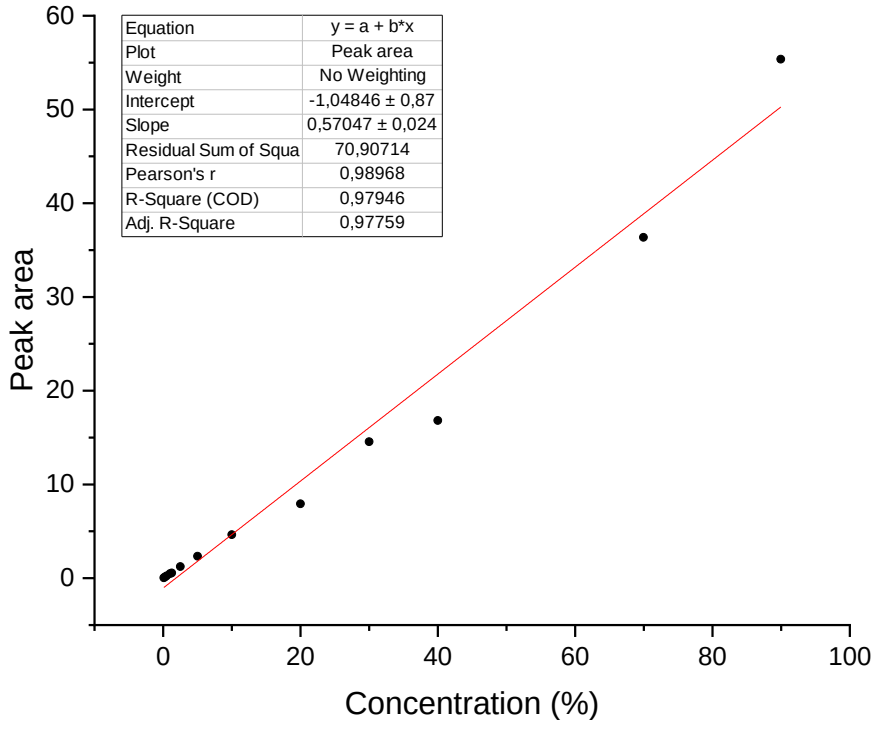

Figure A.8. Calibration line of ChCl-urea.

References

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