

**On the properties of 1-Butyl-3-methylimidazolium octylsulfate Ionic Liquid**

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**Electronic Supplementary Information**

Supplementary Material (ESI) for Green Chemistry  
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**Table S1** Experimental and calculated thermophysical properties of  
[BMIM]OS at atmospheric pressure as a function of temperature.  
Density,  $\rho$ , speed of sound,  $u$ , refractive index,  $n_D$ , isobaric heat  
capacity,  $C_p$ .

| $T / \text{K}$ | $\rho / \text{g cm}^{-3}$ | $u / \text{m s}^{-1}$ | $n_D$   | $C_p / \text{J mol}^{-1} \text{K}^{-1}$ |
|----------------|---------------------------|-----------------------|---------|-----------------------------------------|
| 298.15         | 1.06362                   | 1472.9                | 1.46540 | 635.22                                  |
| 299.15         | 1.06294                   | 1469.8                |         | 636.54                                  |
| 300.15         | 1.06228                   | 1466.7                |         | 638.01                                  |
| 300.65         |                           |                       | 1.46485 |                                         |
| 301.15         | 1.06161                   | 1463.5                |         | 639.36                                  |
| 302.15         | 1.06094                   | 1460.5                |         | 640.73                                  |
| 303.15         | 1.06027                   | 1457.4                | 1.46430 | 642.07                                  |
| 304.15         | 1.05961                   | 1454.4                |         | 643.40                                  |
| 305.15         | 1.05894                   | 1451.3                |         | 644.81                                  |
| 305.65         |                           |                       | 1.46378 |                                         |
| 306.15         | 1.05828                   | 1448.3                |         | 646.15                                  |
| 307.15         | 1.05761                   | 1445.3                |         | 647.45                                  |
| 308.15         | 1.05695                   | 1442.4                | 1.46323 | 648.80                                  |
| 309.15         | 1.05629                   | 1439.4                |         | 650.12                                  |
| 310.15         | 1.05563                   | 1436.5                |         | 651.45                                  |
| 310.65         |                           |                       | 1.46267 |                                         |
| 311.15         | 1.05496                   | 1433.6                |         | 652.77                                  |
| 312.15         | 1.05430                   | 1430.7                |         | 653.98                                  |
| 313.15         | 1.05364                   | 1427.8                | 1.46210 | 655.38                                  |
| 314.15         | 1.05298                   | 1425.0                |         | 656.80                                  |
| 315.15         | 1.05232                   | 1422.1                |         | 658.03                                  |
| 315.65         |                           |                       | 1.46169 |                                         |
| 316.15         | 1.05167                   | 1419.2                |         | 659.29                                  |
| 317.15         | 1.05101                   | 1416.5                |         | 660.75                                  |
| 318.15         | 1.05036                   | 1413.7                | 1.46126 | 662.07                                  |
| 319.15         | 1.04971                   | 1410.9                |         | 663.41                                  |
| 320.15         | 1.04905                   | 1408.1                |         | 664.55                                  |
| 320.65         |                           |                       | 1.46083 |                                         |
| 321.15         | 1.04840                   | 1405.4                |         | 666.12                                  |
| 322.15         | 1.04776                   | 1402.6                |         | 667.53                                  |
| 323.15         | 1.04711                   | 1399.9                | 1.46022 | 668.70                                  |
| 324.15         | 1.04646                   | 1397.2                |         | 670.13                                  |
| 325.15         | 1.04582                   | 1394.5                |         | 671.32                                  |
| 325.65         |                           |                       | 1.45961 |                                         |
| 326.15         | 1.04518                   | 1391.7                |         | 672.98                                  |
| 327.15         | 1.04455                   | 1389.1                |         | 674.11                                  |
| 328.15         | 1.04393                   | 1386.4                | 1.45893 | 675.52                                  |
| 329.15         | 1.04331                   | 1383.7                |         | 676.90                                  |
| 330.15         | 1.04270                   | 1381.0                |         | 678.26                                  |
| 330.65         |                           |                       | 1.45826 |                                         |
| 331.15         | 1.04209                   | 1378.4                |         | 679.69                                  |
| 332.15         | 1.04147                   | 1375.7                |         | 681.16                                  |
| 333.15         | 1.04085                   | 1373.1                | 1.45759 | 682.49                                  |
| 334.15         | 1.04024                   | 1370.4                |         | 683.90                                  |
| 335.15         | 1.03963                   | 1367.8                |         | 685.43                                  |
| 335.65         |                           |                       | 1.45692 |                                         |
| 336.15         | 1.03903                   | 1365.1                |         | 686.85                                  |
| 337.15         | 1.03841                   | 1362.6                |         | 688.26                                  |
| 338.15         | 1.03781                   | 1360.0                | 1.45625 | 689.86                                  |
| 339.15         | 1.03719                   | 1357.4                |         | 691.33                                  |
| 340.15         | 1.03655                   | 1354.8                |         | 692.92                                  |
| 341.15         | 1.03593                   | 1352.2                |         | 694.40                                  |
| 342.15         | 1.03531                   | 1349.6                |         | 696.02                                  |
| 343.15         | 1.03469                   | 1347.1                |         | 697.64                                  |

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**Table S2** Experimental density,  $\rho$ , and calculated isobaric thermal expansivity,  $\alpha_P$ , isothermal compressibility,  $\kappa_T$ , internal pressure,  $P_i$ , isobaric heat capacity,  $C_P$ , and isochoric heat capacity,  $C_V$ , for [BMIM]OS as a function of pressure and temperature

| $P / \text{MPa}$ | $T / \text{K}$               |        |        |        |        |        |        |        |        |        |        |        |
|------------------|------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                  | 318.15                       | 328.15 | 338.15 | 348.15 | 358.15 | 368.15 | 378.15 | 388.15 | 398.15 | 408.15 | 418.15 | 428.15 |
|                  | $\rho / \text{g cm}^{-3}$    |        |        |        |        |        |        |        |        |        |        |        |
| 0.10             | 1.0504                       | 1.0439 | 1.0378 | 1.0367 | 1.0309 | 1.0250 | 1.0192 | 1.0135 | 1.0078 | 1.0024 | 0.9971 | 0.9920 |
| 1.00             | 1.0552                       | 1.0492 | 1.0432 | 1.0371 | 1.0313 | 1.0252 | 1.0194 | 1.0138 | 1.0082 | 1.0028 | 0.9976 | 0.9924 |
| 5.00             | 1.0572                       | 1.0513 | 1.0452 | 1.0391 | 1.0334 | 1.0275 | 1.0218 | 1.0162 | 1.0107 | 1.0054 | 1.0003 | 0.9952 |
| 10.00            | 1.0597                       | 1.0537 | 1.0478 | 1.0418 | 1.0361 | 1.0304 | 1.0247 | 1.0192 | 1.0137 | 1.0086 | 1.0035 | 0.9986 |
| 15.00            | 1.0621                       | 1.0562 | 1.0503 | 1.0444 | 1.0387 | 1.0330 | 1.0275 | 1.0221 | 1.0167 | 1.0116 | 1.0066 | 1.0018 |
| 20.00            | 1.0645                       | 1.0586 | 1.0526 | 1.0468 | 1.0414 | 1.0357 | 1.0302 | 1.0248 | 1.0195 | 1.0145 | 1.0097 | 1.0049 |
| 25.00            | 1.0669                       | 1.0608 | 1.0551 | 1.0493 | 1.0438 | 1.0382 | 1.0328 | 1.0274 | 1.0223 | 1.0174 | 1.0125 | 1.0080 |
| 30.00            | 1.0692                       | 1.0632 | 1.0574 | 1.0518 | 1.0462 | 1.0406 | 1.0353 | 1.0301 | 1.0250 | 1.0201 | 1.0154 | 1.0109 |
| 35.00            | 1.0714                       | 1.0653 | 1.0598 | 1.0541 | 1.0486 | 1.0431 | 1.0378 | 1.0327 | 1.0276 | 1.0228 | 1.0182 | 1.0136 |
| 40.00            | 1.0737                       | 1.0679 | 1.0621 | 1.0563 | 1.0510 | 1.0456 | 1.0404 | 1.0353 | 1.0302 | 1.0254 | 1.0209 | 1.0163 |
| 45.00            | 1.0758                       | 1.0700 | 1.0644 | 1.0587 | 1.0534 | 1.0479 | 1.0426 | 1.0377 | 1.0327 | 1.0280 | 1.0236 | 1.0192 |
| 50.00            | 1.0782                       | 1.0720 | 1.0666 | 1.0610 | 1.0556 | 1.0503 | 1.0451 | 1.0402 | 1.0353 | 1.0306 | 1.0261 | 1.0218 |
| 55.00            | 1.0801                       | 1.0744 | 1.0686 | 1.0633 | 1.0579 | 1.0526 | 1.0474 | 1.0426 | 1.0376 | 1.0330 | 1.0283 | 1.0243 |
| 60.00            | 1.0823                       | 1.0761 | 1.0711 | 1.0657 | 1.0602 | 1.0550 | 1.0496 | 1.0447 | 1.0398 | 1.0351 | 1.0311 | 1.0266 |
|                  | $\alpha_P / \text{K}^{-1}$   |        |        |        |        |        |        |        |        |        |        |        |
| 0.10             | 0.638                        | 0.621  | 0.604  | 0.588  | 0.573  | 0.559  | 0.546  | 0.533  | 0.521  | 0.509  | 0.498  | 0.487  |
| 1.00             | 0.637                        | 0.619  | 0.603  | 0.587  | 0.572  | 0.558  | 0.544  | 0.531  | 0.519  | 0.507  | 0.496  | 0.486  |
| 5.00             | 0.632                        | 0.614  | 0.597  | 0.581  | 0.566  | 0.551  | 0.538  | 0.525  | 0.512  | 0.500  | 0.489  | 0.478  |
| 10.00            | 0.626                        | 0.608  | 0.591  | 0.574  | 0.559  | 0.544  | 0.530  | 0.517  | 0.504  | 0.492  | 0.480  | 0.470  |
| 15.00            | 0.620                        | 0.602  | 0.584  | 0.568  | 0.552  | 0.537  | 0.523  | 0.509  | 0.496  | 0.484  | 0.472  | 0.461  |
| 20.00            | 0.615                        | 0.596  | 0.578  | 0.561  | 0.545  | 0.530  | 0.516  | 0.502  | 0.489  | 0.477  | 0.465  | 0.454  |
| 25.00            | 0.609                        | 0.590  | 0.573  | 0.555  | 0.539  | 0.524  | 0.509  | 0.495  | 0.482  | 0.470  | 0.458  | 0.447  |
| 30.00            | 0.604                        | 0.585  | 0.567  | 0.550  | 0.533  | 0.518  | 0.503  | 0.489  | 0.476  | 0.463  | 0.451  | 0.440  |
| 35.00            | 0.600                        | 0.580  | 0.562  | 0.544  | 0.528  | 0.512  | 0.497  | 0.483  | 0.469  | 0.457  | 0.445  | 0.433  |
| 40.00            | 0.595                        | 0.575  | 0.557  | 0.539  | 0.523  | 0.507  | 0.491  | 0.477  | 0.464  | 0.451  | 0.439  | 0.427  |
| 45.00            | 0.590                        | 0.571  | 0.552  | 0.534  | 0.517  | 0.501  | 0.486  | 0.472  | 0.458  | 0.445  | 0.433  | 0.421  |
| 50.00            | 0.586                        | 0.566  | 0.547  | 0.530  | 0.513  | 0.496  | 0.481  | 0.466  | 0.453  | 0.440  | 0.427  | 0.416  |
| 55.00            | 0.582                        | 0.562  | 0.543  | 0.525  | 0.508  | 0.492  | 0.476  | 0.461  | 0.448  | 0.434  | 0.422  | 0.411  |
| 60.00            | 0.578                        | 0.558  | 0.539  | 0.521  | 0.503  | 0.487  | 0.471  | 0.457  | 0.443  | 0.430  | 0.417  | 0.406  |
|                  | $\kappa_T / \text{TPa}^{-1}$ |        |        |        |        |        |        |        |        |        |        |        |
| 0.10             | 492.4                        | 505.8  | 519.8  | 534.5  | 549.7  | 565.6  | 582.1  | 599.2  | 616.9  | 635.0  | 653.7  | 672.7  |
| 1.00             | 490.1                        | 503.4  | 517.3  | 531.8  | 546.9  | 562.6  | 579.0  | 595.9  | 613.3  | 631.3  | 649.7  | 668.5  |
| 5.00             | 480.4                        | 493.1  | 506.5  | 520.4  | 534.8  | 549.8  | 565.4  | 581.5  | 598.2  | 615.2  | 632.7  | 650.5  |
| 10.00            | 468.8                        | 480.9  | 493.6  | 506.7  | 520.5  | 534.7  | 549.4  | 564.6  | 580.3  | 596.3  | 612.7  | 629.4  |
| 15.00            | 457.7                        | 469.3  | 481.3  | 493.9  | 506.9  | 520.4  | 534.3  | 548.7  | 563.5  | 578.6  | 594.0  | 609.7  |
| 20.00            | 447.2                        | 458.3  | 469.7  | 481.7  | 494.0  | 506.8  | 520.1  | 533.7  | 547.6  | 561.9  | 576.5  | 591.3  |
| 25.00            | 437.2                        | 447.7  | 458.7  | 470.1  | 481.9  | 494.0  | 506.6  | 519.5  | 532.7  | 546.3  | 560.0  | 573.9  |
| 30.00            | 427.6                        | 437.7  | 448.2  | 459.1  | 470.3  | 481.9  | 493.8  | 506.1  | 518.7  | 531.5  | 544.5  | 557.7  |
| 35.00            | 418.5                        | 428.2  | 438.2  | 448.6  | 459.3  | 470.4  | 481.7  | 493.4  | 505.4  | 517.5  | 529.9  | 542.3  |
| 40.00            | 409.8                        | 419.1  | 428.7  | 438.6  | 448.8  | 459.4  | 470.3  | 481.4  | 492.7  | 504.3  | 516.0  | 527.9  |
| 45.00            | 401.5                        | 410.3  | 419.5  | 429.0  | 438.9  | 449.0  | 459.3  | 469.9  | 480.8  | 491.8  | 502.9  | 514.2  |
| 50.00            | 393.5                        | 402.0  | 410.8  | 419.9  | 429.3  | 439.0  | 448.9  | 459.1  | 469.4  | 479.9  | 490.5  | 501.2  |
| 55.00            | 385.8                        | 394.0  | 402.5  | 411.2  | 420.2  | 429.5  | 439.0  | 448.7  | 458.6  | 468.6  | 478.7  | 488.9  |
| 60.00            | 378.4                        | 386.3  | 394.5  | 402.9  | 411.6  | 420.4  | 429.5  | 438.8  | 448.3  | 457.9  | 467.5  | 477.3  |
|                  | $P_i / \text{MPa}$           |        |        |        |        |        |        |        |        |        |        |        |
| 0.10             | 412.4                        | 402.6  | 392.8  | 383.1  | 373.4  | 363.8  | 354.3  | 345.1  | 336.0  | 327.1  | 318.4  | 310.1  |
| 1.00             | 412.6                        | 402.8  | 393.0  | 383.2  | 373.5  | 363.9  | 354.4  | 345.1  | 335.9  | 327.0  | 318.4  | 310.0  |
| 5.00             | 413.6                        | 403.7  | 393.7  | 383.8  | 373.9  | 364.2  | 354.6  | 345.1  | 335.9  | 326.9  | 318.2  | 309.8  |
| 10.00            | 414.9                        | 404.7  | 394.6  | 384.5  | 374.4  | 364.5  | 354.7  | 345.2  | 335.8  | 326.7  | 317.9  | 309.4  |
| 15.00            | 416.1                        | 405.8  | 395.4  | 385.1  | 374.9  | 364.8  | 354.9  | 345.2  | 335.7  | 326.5  | 317.6  | 309.0  |
| 20.00            | 417.3                        | 406.8  | 396.2  | 385.8  | 375.4  | 365.1  | 355.0  | 345.1  | 335.5  | 326.2  | 317.2  | 308.6  |
| 25.00            | 418.5                        | 407.8  | 397.0  | 386.4  | 375.8  | 365.4  | 355.1  | 345.1  | 335.3  | 325.9  | 316.8  | 308.1  |
| 30.00            | 419.6                        | 408.7  | 397.8  | 387.0  | 376.2  | 365.6  | 355.2  | 345.0  | 335.1  | 325.5  | 316.4  | 307.6  |
| 35.00            | 420.8                        | 409.6  | 398.6  | 387.5  | 376.6  | 365.8  | 355.2  | 344.9  | 334.8  | 325.2  | 315.9  | 307.1  |
| 40.00            | 421.9                        | 410.6  | 399.3  | 388.0  | 376.9  | 366.0  | 355.2  | 344.7  | 334.6  | 324.8  | 315.4  | 306.6  |
| 45.00            | 422.9                        | 411.4  | 400.0  | 388.6  | 377.3  | 366.1  | 355.2  | 344.6  | 334.2  | 324.3  | 314.9  | 306.0  |
| 50.00            | 424.0                        | 412.3  | 400.6  | 389.0  | 377.5  | 366.2  | 355.1  | 344.3  | 333.9  | 323.9  | 314.3  | 305.3  |
| 55.00            | 425.0                        | 413.1  | 401.3  | 389.5  | 377.8  | 366.3  | 355.1  | 344.1  | 333.5  | 323.4  | 313.7  | 304.7  |
| 60.00            | 426.0                        | 414.0  | 401.9  | 389.9  | 378.1  | 366.4  | 355.0  | 343.9  | 333.1  | 322.9  | 313.1  | 304.0  |

Table S2 Continued

| <i>P</i> / MPa | <i>T</i> / K                                               |        |        |        |        |        |        |        |        |        |        |        |
|----------------|------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                | 318.15                                                     | 328.15 | 338.15 | 348.15 | 358.15 | 368.15 | 378.15 | 388.15 | 398.15 | 408.15 | 418.15 | 428.15 |
|                | <i>C<sub>p</sub></i> / J mol <sup>-1</sup> K <sup>-1</sup> |        |        |        |        |        |        |        |        |        |        |        |
| 0.10           | 662.07                                                     | 675.52 | 689.86 | 705.93 | 724.93 | 748.20 | 777.34 | 814.16 | 860.74 | 919.34 | 992.49 | 1082.9 |
| 1.00           | 662.19                                                     | 675.65 | 689.97 | 706.06 | 725.05 | 748.32 | 777.45 | 814.28 | 860.85 | 919.45 | 992.60 | 1083.0 |
| 5.00           | 662.79                                                     | 676.24 | 690.55 | 706.63 | 725.61 | 748.87 | 777.99 | 814.80 | 861.37 | 919.96 | 993.09 | 1083.5 |
| 10.00          | 663.56                                                     | 676.99 | 691.29 | 707.35 | 726.32 | 749.57 | 778.68 | 815.48 | 862.03 | 920.61 | 993.73 | 1084.1 |
| 15.00          | 664.35                                                     | 677.76 | 692.04 | 708.10 | 727.05 | 750.28 | 779.38 | 816.17 | 862.71 | 921.27 | 994.38 | 1084.7 |
| 20.00          | 665.15                                                     | 678.55 | 692.82 | 708.86 | 727.80 | 751.02 | 780.10 | 816.88 | 863.40 | 921.95 | 995.04 | 1085.4 |
| 25.00          | 665.96                                                     | 679.35 | 693.60 | 709.63 | 728.56 | 751.77 | 780.84 | 817.61 | 864.11 | 922.64 | 995.72 | 1086.0 |
| 30.00          | 666.78                                                     | 680.16 | 694.41 | 710.42 | 729.34 | 752.53 | 781.59 | 818.34 | 864.83 | 923.35 | 996.40 | 1086.7 |
| 35.00          | 667.62                                                     | 680.99 | 695.22 | 711.22 | 730.13 | 753.31 | 782.36 | 819.09 | 865.56 | 924.06 | 997.09 | 1087.3 |
| 40.00          | 668.47                                                     | 681.82 | 696.04 | 712.04 | 730.93 | 754.10 | 783.13 | 819.85 | 866.31 | 924.78 | 997.78 | 1088.0 |
| 45.00          | 669.33                                                     | 682.67 | 696.88 | 712.86 | 731.74 | 754.90 | 783.92 | 820.62 | 867.06 | 925.51 | 998.48 | 1088.7 |
| 50.00          | 670.19                                                     | 683.53 | 697.72 | 713.69 | 732.56 | 755.71 | 784.71 | 821.40 | 867.81 | 926.24 | 999.19 | 1089.4 |
| 55.00          | 671.07                                                     | 684.39 | 698.58 | 714.54 | 733.40 | 756.52 | 785.51 | 822.18 | 868.58 | 926.98 | 999.90 | 1090.0 |
| 60.00          | 671.95                                                     | 685.26 | 699.44 | 715.39 | 734.23 | 757.35 | 786.32 | 822.97 | 869.35 | 927.73 | 1000.6 | 1090.7 |
|                | <i>C<sub>v</sub></i> / J mol <sup>-1</sup> K <sup>-1</sup> |        |        |        |        |        |        |        |        |        |        |        |
| 0.10           | 575.05                                                     | 592.47 | 610.53 | 630.17 | 652.56 | 679.03 | 711.20 | 750.92 | 800.23 | 861.44 | 937.05 | 1029.8 |
| 1.00           | 575.14                                                     | 592.56 | 610.64 | 630.29 | 652.68 | 679.16 | 711.35 | 751.08 | 800.39 | 861.61 | 937.22 | 1029.9 |
| 5.00           | 575.56                                                     | 593.04 | 611.16 | 630.86 | 653.30 | 679.82 | 712.05 | 751.82 | 801.17 | 862.40 | 938.03 | 1030.8 |
| 10.00          | 576.08                                                     | 593.62 | 611.82 | 631.58 | 654.08 | 680.67 | 712.94 | 752.74 | 802.12 | 863.38 | 939.02 | 1031.7 |
| 15.00          | 576.61                                                     | 594.22 | 612.48 | 632.31 | 654.86 | 681.49 | 713.81 | 753.65 | 803.06 | 864.33 | 939.99 | 1032.7 |
| 20.00          | 577.14                                                     | 594.81 | 613.13 | 633.02 | 655.64 | 682.31 | 714.67 | 754.54 | 803.98 | 865.28 | 940.94 | 1033.7 |
| 25.00          | 577.67                                                     | 595.40 | 613.80 | 633.74 | 656.40 | 683.12 | 715.52 | 755.43 | 804.89 | 866.20 | 941.86 | 1034.6 |
| 30.00          | 578.21                                                     | 596.01 | 614.45 | 634.46 | 657.16 | 683.93 | 716.38 | 756.31 | 805.80 | 867.11 | 942.78 | 1035.5 |
| 35.00          | 578.74                                                     | 596.59 | 615.12 | 635.18 | 657.93 | 684.74 | 717.22 | 757.19 | 806.69 | 868.02 | 943.68 | 1036.4 |
| 40.00          | 579.28                                                     | 597.22 | 615.78 | 635.88 | 658.70 | 685.55 | 718.07 | 758.06 | 807.57 | 868.91 | 944.57 | 1037.2 |
| 45.00          | 579.82                                                     | 597.82 | 616.45 | 636.61 | 659.46 | 686.35 | 718.89 | 758.92 | 808.45 | 869.79 | 945.45 | 1038.1 |
| 50.00          | 580.39                                                     | 598.41 | 617.11 | 637.33 | 660.22 | 687.15 | 719.73 | 759.77 | 809.32 | 870.66 | 946.31 | 1038.9 |
| 55.00          | 580.91                                                     | 599.03 | 617.77 | 638.05 | 660.98 | 687.95 | 720.56 | 760.63 | 810.18 | 871.53 | 947.14 | 1039.8 |
| 60.00          | 581.48                                                     | 599.62 | 618.45 | 638.78 | 661.75 | 688.76 | 721.37 | 761.45 | 811.02 | 872.36 | 948.00 | 1040.6 |