Tris-imidazolium and benzimidazolium ionic liquids: A new class of biodegradable surfactants

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Supplementary Information

Structural and characterization data

Tris-((2-chloro-acetayloxy)methyl)ethane (3)

Colourless crystals; Yield: 27.94 g (96%); m.p 42-44°C. Molecular Formula: C11H15Cl3O6; Mol. Wt.: 349.59; FTIR (cm⁻¹): 2960, 2852 (C-H)Aliph, 1732 (C=O), 1174, 1150 (O-C), 789 (C-Cl); ¹H-NMR (400 MHz, CDCl₃) δ ppm: 4.08 (s, 6H, CH₂-Cl), 4.04 (s, 6H, CH₂-O), 1.02 (s, 3H, CH₃); ¹³C-NMR (100 MHz, CDCl₃) δ ppm: 167.00 (C=O), 66.98 (CH₂-O), 40.73 (CH₂-Cl), 38.42 (-C-), 16.92 (CH₃); EIMS (m/z): 347.9 (10%)(M), 273.0 (12%), 197.0 (45%), 121.0 (66%), 90.9 (100%).

1-Hexyl-1H-imidazole (6c)

This compound was prepared by using 1-bromohexane (10.10 g, 8.60 mL, 61.2 mmole) to give pale yellow oil in 91% yield (8.48 g). Molecular Formula: C₉H₁₆N₂; Mol. Wt.: 152.24; FTIR (cm⁻¹): 3106 (C-H)Ar, 2955, 2929, 2858 (C-H)Aliph, 1506 (C=N), 1460 (C=C)Ar; ¹H-NMR (400 MHz, CDCl₃) δ ppm: 7.29 (s, H, C-HImidazole), 6.88 (s, H, C-HImidazole), 6.75 (s, H, C-HImidazole), 3.76 (t, J = 7.02 Hz, 2H, α-CH₂), 1.64-1.56 (m, 2H, β-CH₂), 1.13 (bs, 6H, bulk-CH₂), 0.72 (t, J = 6.71 Hz, 3H, ω-CH₃); ¹³C-NMR (100 MHz, CDCl₃) δ ppm: 136.95 (CHImidazole), 129.19 (CHImidazole), 118.75 (CHImidazole), 46.91 (α-CH₂), 31.17 (ω-2), 30.98 (bulk-CH₂), 26.02 (β), 22.35 (ω-1), 13.90 (ω); EIMS (m/z): 152.1 (15%)(M), 137.0 (3%), 125.1 (35%), 109.1 (6%), 96.0 (19%), 84.0 (89%), 69.0 (23%), 49.0 (100%).

1-Octyl-1H-imidazole (6d)

This compound was prepared using 1-bromooctane (11.82 g, 10.65 mL, 61.2 mmole) to give pale yellow oil in 94% yield (10.37 g). Molecular Formula: C₁₁H₂₀N₂; Mol. Wt.: 180.29; FTIR (cm⁻¹): 3108 (C-H)Ar, 2955, 2925, 2855 (C-H)Aliph, 1677 (C=N), 1506, 1461 (C=C)Ar; ¹H-NMR (400 MHz, CDCl₃) δ ppm: 7.32 (s, H, C-HImidazole), 6.81 (s, H, C-HImidazole), 6.77 (s, H, C-HImidazole), 3.78 (t, J = 7.07 Hz, 2H, α-CH₂), 1.66-1.59 (m, 2H, β-CH₂), 1.15 (bs, 10H, bulk-CH₂), 0.75 (t, J = 6.71 Hz, 3H, ω-CH₃); ¹³C-NMR (100 MHz, CDCl₃) δ ppm: 136.95 (CHImidazole), 129.19 (CHImidazole), 118.75 (CHImidazole), 46.91 (α-CH₂), 31.17 (ω-2), 30.98 (bulk-CH₂), 26.02 (β), 22.35 (ω-1), 13.90 (ω); EIMS (m/z): 152.1 (15%)(M), 137.0 (3%), 125.1 (35%), 109.1 (6%), 96.0 (19%), 84.0 (89%), 69.0 (23%), 49.0 (100%).

1-Decyl-1H-imidazole (6e)

This compound was prepared by using 1-bromodecane (13.54 g, 12.65 mL, 61.2 mmole) to give pale yellow oil in 93% yield (11.86g). Molecular Formula: C₁₃H₂₄N₂; Mol. Wt.: 208.34; FTIR (cm⁻¹): 3107 (C-
5.18 (s, 2H, Ar-CH$_2$); EIMS (m/z): 158.0 (15%)(M), 131.0 (10%), 118.0 (15%), 104.0 (11%), 91.0 (100%), 77.0 (7.5%), 65.0 (25%), 43.1 (14%).

1-Butyl-1H-benzimidazole (7b)

This compound was prepared by using 1-bromobutane (8.38 g, 6.57 mL, 61.2 mmole) to give yellow oil in 83% yield (8.84 g). Molecular Formula: C$_{13}$H$_{14}$N$_2$; Mol. Wt.: 174.24; FTIR (cm$^{-1}$): 3055 (C-H)$_{Ar}$, 2930, 2855 (C-H)$_{Aliph}$, 1612 (C=N), 1494, 1450 (C=C)$_{Ar}$; $^1$H-NMR (400 MHz, DMSO-d$_6$) δ ppm: 8.21 (s, H, C-H$_{Bimidazole}$), 7.64 (d, J = 8.05 Hz, H, C-H$_{Ar}$), 7.58 (d, J = 8.05 Hz, H, C-H$_{Ar}$), 7.26-7.16 (m, 2H, CH$_{Ar}$), 4.23 (t, J = 7.07 Hz, 2H, α-CH$_2$), 1.72-1.79 (m, 2H, β-CH$_2$), 1.28-1.18 (m, 2H, (ω-1)), 0.87 (t, J = 7.23 Hz, 3H, ω-CH$_3$); $^{13}$C-NMR (100 MHz, DMSO-d$_6$) δ ppm: 144.49 (CH$_{Bimidazole}$), 144.07 (C$_{Ar}$), 134.55 (C$_{Ar}$), 122.68 (CH$_{Ar}$), 121.85 (CH$_{Ar}$), 119.97 (CH$_{Ar}$), 110.82 (CH$_{Ar}$), 44.30 (α-CH$_2$), 31.98 (ω-2), 19.87 (ω-1), 22.29 (β), 26.15 (β), 207.2 (38%), 193.1 (22%), 179.1 (28%), 165.1 (14%), 151.1 (25%), 137.1 (18%), 123.1 (35%), 109.1 (28%), 96.0 (48%), 82.0 (100%), 69.0 (48%), 55.0 (45%), 43.1 (35%).
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13.86 (ω); EIMS (m/z): 174.1 (50%)(M), 159.0 (12%), 145.0 (18%), 131.0 (100%), 118.0 (30%), 104.0 (12%), 90.0 (10%) 77.0 (25%).

1-Hexyl-1H-benzimidazole (7c)

This compound was prepared by using 1-bromohexane (10.10 g, 8.63 mL, 61.2 mmole) to give yellow oil in 88% yield (10.90 g). Molecular Formula: C_{13}H_{18}N_{2}; Mol. Wt.: 202.30; FTIR (cm⁻¹): 3058 (ω); EIMS (m/z): 174.1 (50%)(M), 159.0 (12%), 145.0 (18%), 131.0 (100%), 118.0 (30%), 104.0 (12%), 90.0 (10%) 77.0 (25%).

1-Octyl-1H-benzimidazole (7d)

This compound was prepared by using 1-bromooctane (11.82 g, 10.65 mL, 61.2 mmole) to give yellow oil in 90% yield (12.69 g). Molecular Formula: C_{15}H_{22}N_{2}; Mol. Wt.: 230.35; FTIR (cm⁻¹): 3058 (ω); EIMS (m/z): 202.1 (43%)(M), 187.1 (5%), 173.1 (18%), 159.0 (15%), 145.0 (15%), 131.0 (100%), 118.0 (19%), 104.0 (12%), 90.0 (7%) 77.0 (17%).

1-Decyl-1H-benzimidazole (7e)

This compound was prepared by using 1-bromodecane (13.53 g, 12.65 mL, 61.2 mmole) to give a yellow semi-solid in 91% yield (14.38 g). Molecular Formula: C_{17}H_{26}N_{2}; Mol. Wt.: 258.40; FTIR (cm⁻¹): 3057 (ω); EIMS (m/z): 258.2 (60%)(M), 243.2 (16%), 229.1 (32%), 215.1 (27%), 201.1 (30%), 187.1 (36%), 173.1 (53%), 159.0 (39%), 145.0 (50%), 131.0 (100%), 118.0 (70%), 104.0 (21%), 90.0 (10%), 77.0 (25%).
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1-Dodecyl-1H-benzimidazole (7f)

This compound was prepared by using 1-bromododecane (15.25 g, 14.70 mL, 61.2 mmole) to give yellow semi-solid in 94% yield (16.48 g). Molecular Formula: C_{19}H_{36}N_{2}; Mol. Wt.: 286.45; FTIR (cm⁻¹): 3055 (C-H)ₜ, 2958, 2924, 2857 (C-H)ₛ; ¹H-NMR (400 MHz, CDCl₃) δ ppm: 7.84 (s, H, C-Hₜ); 7.82-7.77 (m, H, C-Hₜ), 7.37-7.34 (m, H, C-Hₜ), 7.29-7.23 (m, 2H, CHₐ), 4.09 (t, J = 7.09 Hz, 2H, α-CH₂), 1.87-1.80 (m, 6H, β-CH₂), 1.23 (bs, 18H, (bulk-CH₂)), 0.87 (t, J = 7.09 Hz, 3H, ω-CH₃). ¹⁴C-NMR (100 MHz, CDCl₃) δ ppm: 144.21 (Cₜ), 122.57 (CHₐ), 121.78 (CHₐ), 109.49 (CHₐ), 44.89 (α-CH₂), 31.74 (ω-2), 29.62, 29.42 (2), 29.43, 29.25, 29.16, 28.91 (bulk-CH₂), 26.63 (β), 22.51 (ω-1), 13.94 (ω). EIMS (m/z): 286.2 (62%)(M), 271.2 (18%), 257.2 (30%), 243.2 (32%), 229.1 (30%), 215.1 (32%), 201.1 (57%), 187.1 (40%), 173.1 (50%), 159.1 (40%), 145.0 (55%), 131.0 (100%), 118.0 (60%), 104.0 (21%), 90.0 (10%), 77.0 (20%).

1-Benzyl-1H-benzimidazole (7g)

This compound was prepared by using benzyl bromide (10.47 g, 7.28 mL, 61.2 mmole) to give a brown solid re-crystallized from hexane gave off-white crystals in 90% yield (11.47 g); m.p 108-110°C. Molecular Formula: C_{14}H_{12}N₂; Mol. Wt.: 208.26; FTIR (cm⁻¹): 3081, 3032 (C-H)ₜ, 2944 (C-H)ₛ; ¹H-NMR (400 MHz, DMSO-d₆) δ ppm: 8.41 (s, H, C-Hₜ); 7.67-7.64 (m, H, C-Hₜ), 7.51-7.49 (m, H, C-Hₜ), 7.34-7.14 (m, 7H, C-Hₜ), 5.49 (s, 2H, Ar-CH₂-N); ¹⁵C-NMR (100 MHz, DMSO-d₆) δ ppm: 143.57 (Cₜ), 136.93 (-Cₚ-CH₂-), 133.65 (Cₚₚ), 128.67 (2CHₐ), 127.70 (CHₐ), 127.35 (2CHₐ), 122.37 (CHₚₚ), 119.48 (CHₚₚ), 110.67 (CHₚₚ), 47.60 (Ar-CH₂-); EIMS (m/z): 208.1 (58%)(M), 103.0 (3%), 91.1 (100%), 77.0 (3%), 65.0 (13%).

Tris-((N-butyl-imidazoliumyl-acetayloxy)methyl)ethane chloride (8b)

This compound was prepared analogously to 8a using tris-((2-chloro-acetayloxy)methyl)ethane (compound 3) (1.9 g, 5.43 mmol) and 1-butylimidazole (2.02 g, 2.14 mL, 16.3 mmol) to provide a viscous hygroscopic syrup in 98% yield (3.85 g). Molecular Formula: C_{32}H_{51}ClN_{6}O_{6}; Mol. Wt.: 722.14; FTIR (cm⁻¹): 3058 (C-H)ₜ, 2959, 2933, 2873 (C-H)ₛ; ¹H-NMR (400 MHz, DMSO-d₆) δ ppm: 9.56 (bt-s, 3H, C-Hₜ), 9.51 (bt-s, 3H, C-Hₜ), 9.46 (bt-s, 3H, C-Hₜ), 7.89 (dt, J = 6.83, 1.71 Hz, 6H, C-Hₜₚₚ, major), 7.85 (dt, J = 6.83, 1.71 Hz, 6H, C-Hₜₚₚ, minor), 5.45 (s, 6H, O-CH₂, major), 5.40 (s, 6H, O-CH₂, minor), 4.25 (t, J = 7.07 Hz, 6H, α-CH₂, major), 4.04 (s, 6H, N-CH₂) 3.95 (t, J = 7.07 Hz, 6H, α-CH₂, minor), 1.80-1.73 (m, 6H, β-CH₂, major), 1.69-1.62 (m, 6H, β-CH₂, minor), 1.28-1.14 (m, 6H, (ω-1)), 0.93 (s, 3H, CH₃), 0.88 (t, J = 7.32 Hz, 9H, ω-CH₃); ¹³C-NMR (100 MHz, DMSO-d₆) δ ppm: 166.72 (C-O), 137.44 (CHₚₚ), 137.06 (CHₚₚₚ), 123.95 (CHₚₚₚ), 122.14 (CHₚₚₚ), 66.54 (CH₂-O), 49.60 (CH₂-N), 48.78 (α-CH₂), 38.16 (-C-), 32.56 ((ω-2), minor), 31.40 ((ω-2), major), 19.14 ((ω-1), minor), 18.79 ((ω-1), major), 16.38 (CH₃), 13.42 ((ω), minor), 13.32 ((ω), major); HRMS: m/z, [M⁺³⁻2H]⁻3Cl⁻ calcld. for C_{32}H_{49}N_{6}O_{6}⁺ : 613.3714, found: 613.3748.
Tris-((N-octyl-imidazoliumyl-acetayloxy)methyl)ethane chloride (8d)

This compound was prepared analogously to 8a using tris-((2-chloro-acetayloxy)methyl)ethane (compound 3) (1.9 g, 5.43 mmol) and 1-octylimidazole (6d) (2.94 g, 16.3 mmol) to provide a viscous hygroscopic syrup in 99% yield (5.15 g). Molecular Formula: C_{44}H_{75}Cl_{10}N_6O_6; Mol. Wt.: 890.46; FTIR (cm⁻¹): 3058 (C-H)Ar, 2954, 2929, 2849 (C-H)Aliph, 1749 (C-O), 1668 (C=N), 1564, 1464 (C=C)Ar, 1199, 1167 (C-O); ¹H-NMR (400 MHz, DMSO-d₆) δ ppm: 9.55 (bt-s, 3H, C-Himidazole, major), 9.48 (bt-s, 3H, C-Himidazole, minor), 9.41 (bt-s, 3H, C-Himidazole, minor), 7.89 (dt, 6H, J=8.86, 1.72 Hz, C-Himidazole, major), 7.85 (dt, 6H, J=8.86, 1.72 Hz, C-Himidazole, minor), 5.45 (s, 6H, O-CH₂, major), 5.39 (s, 6H, O-CH₂, minor), 5.37 (s, 6H, O-CH₂, minor), 4.24 (t, J=7.15 Hz, 6H, α-CH₂), 4.06 (bs, 6H, N-CH₂), 1.82-1.74 (m, 6H, β-CH₂), 1.24 (bs, 30H, bulk-CH₂), 0.95 (s, 3H, CH₃), 0.85 (t, J=6.98 Hz, 9H, α-CH₃); ¹³C-NMR (100 MHz, DMSO-d₆) δ ppm: 167.99 (C=O, major), 166.85 (C=O, minor), 137.31 (CHimidazole, minor), 137.21 (CHimidazole, major), 123.87 (CHimidazole), 122.05 (CHimidazole, minor), 121.91 (CHimidazole, major), 63.92 (CH₂-O, major), 63.05 (CH₂-O, minor), 49.75 (CH₂-N, major), 49.63 (CH₂-N, minor), 48.94 (α-CH₂, minor), 48.87 (α-CH₂, major), 40.62 (β, 29.34, 28.44, 28.26 (bulk-CH₂), 25.39 (β), 22.01 (ω-1), 16.57 (CH₃, major), 16.42 (CH₃, minor), 13.89 (ω); HRMS: m/z, [M+3−2H]−3Cl⁻ calcd. for C_{44}H_{75}N_{6}O_{6}^{5+}: 781.5592, found: 781.5608.

Tris-((N-decyl-imidazoliumyl-acetayloxy)methyl)ethane chloride (8e)

This compound was prepared analogously to 8a using tris-((2-chloro-acetayloxy)methyl)ethane (compound 3) (1.9 g, 5.43 mmol) and 1-decylimidazole (6e) (3.39 g, 16.3 mmol) to provide a viscous hygroscopic syrup in 99% yield (5.24 g). Molecular Formula: C_{50}H_{85}Cl_{14}N_{6}O_{6}; Mol. Wt.: 974.62; FTIR (cm⁻¹): 3058 (C-H)Ar, 2955, 2925, 2855 (C-H)Aliph, 1749 (C-O), 1668 (C=N), 1564, 1462 (C=C)Ar, 1199, 1165 (C-O); ¹H-NMR (400 MHz, DMSO-d₆) δ ppm: 9.64 (bt-s, 3H, C-Himidazole, major), 9.57 (bt-s, 3H, C-Himidazole, minor), 9.51 (bt-s, 3H, C-Himidazole, minor), 7.94 (t, J=1.81 Hz, 6H, C-Himidazole, major), 7.89 (t, J=1.81 Hz, 6H, C-Himidazole, major), 7.84 (t, J=1.81 Hz, 6H, C-Himidazole, minor), 7.81 (t, J=1.81 Hz, 6H, C-Himidazole, minor), 5.49 (s, 6H, O-CH₂, major), 5.45 (s, 6H, O-CH₂, minor), 5.40 (s, 6H, O-CH₂, minor), 4.25 (t, J=7.25 Hz, 6H, α-CH₂, major), 4.05 (s, 6H, N-CH₂), 4.01 (t, 6H, J=7.25 Hz, α-CH₂, minor), 1.82-1.75 (m, 6H, β-CH₂, major), 1.73-1.67 (m, 6H, β-CH₂, minor), 1.24 (bs, 42H, bulk-CH₂), 0.95 (s, 3H, CH₃), 0.84 (t, 9H, J=6.80 Hz, α-CH₃); ¹³C-NMR (100 MHz, DMSO-d₆) δ ppm: 166.72 (C-O), 137.41 (CHimidazole, major), 136.42 (CHimidazole, minor), 132.91 (CHimidazole), 122.04(CHimidazole), 66.48 (CH₂-O), 49.52 (CH₂-N), 48.92 (α-CH₂), 38.08 (C-C), 31.15 (ω-2), 30.16 (minor), 29.40 (major), 28.53, 28.49, 28.37, 28.31 (bulk-CH₂), 25.76 (β, minor), 25.47 (β, major), 22.05 (ω-1), 16.39 (CH₃), 13.93 (ω); HRMS: m/z, [M+3−2H]−3Cl⁻ calcd. for C_{50}H_{85}N_{6}O_{6}^{5+}: 865.6531, found: 865.6518.

Tris-((N-hexyl-benzimidazoliumyl-acetayloxy)methyl)ethane chloride (9c)

This compound was prepared analogously to 9b using tris-((2-chloro-acetayloxy)methyl)ethane (compound 3) (1.9 g, 5.43 mmol) and 1-hexylbenzimidazole (7c) (3.30 g, 16.3 mmol) to provide a viscous hygroscopic syrup in 99% yield (5.15 g). Molecular Formula: C_{50}H_{85}Cl_{10}N_{6}O_6; Mol. Wt.: 956.48; FTIR (cm⁻¹): 3020 (C-H)Ar, 2954, 2929, 2859 (C-H)Aliph, 1748 (C-O), 1617(C=N), 1563, 1486, 1464 (C=C)Ar, 1196, 1160 (C-O); ¹H-NMR (400 MHz, DMSO-d₆) δ ppm: 10.39 (s, 3H, C-Himidazole, major),
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This compound was prepared analogously to 9b using tris-((2-chloro-acetamido)methyl)ethane (compound 3) (1.9 g, 5.43 mmol) and 1-benzyl-benzimidazole (7d) (3.75 g, 16.3 mmol) to provide a viscous hygroscopic syrup in 98% yield (5.54g). Molecular Formula: C_{53}H_{87}Cl_{3}N_{6}O_{6}; Mol. Wt.: 1040.64; FTIR (cm^{-1}): 3134 (C-H), 2955, 2925, 2855 (C-H), 1749 (C=O), 1618 (C=N), 1562, 1486 1462 (C=C), 1199 (C-O); 1H-NMR (400 MHz, DMSO-d_{6}) δ ppm: 10.39 (s, 3H, C=H_BImidazole, major), 10.32 (s, 3H, C=H_BImidazole, minor), 10.26 (s, 3H, C=H_BImidazole, minor), 8.16-8.10 (m, 6H, CH_{Ar}, 7.70-7.61 (m, 6H, CH_{Ar}, 7.29-7.19 (m, 6H, CH_{Ar}, minor), 5.85 (s, 6H, O-CH_{2}, major), 5.80 (s, 6H, O-CH_{2}, minor), 4.57 (t, J=7.07, 6H, α-CH_{2}, major), 4.25 (t, J=7.07, 6H, α-CH_{2}, minor), 4.04 (s, 6H, N-CH_{2}, minor), 3.99 (s, 6H, N-CH_{2}, major), 1.92-1.85 (m, 6H, CH_{2}), 0.86 (s, 3H, CH_{3}, 0.82 (t, 9H, overlap, CH_{3}); ^13C-NMR (100 MHz, DMSO-d_{6}) δ ppm: 167.83 (C=O, major), 166.51 (C=O, minor), 143.22 (CH_BImidazole), 131.56 (C_{Ar}), 130.62 (C_{Ar}), 126.79 (CH_{Ar}), 126.57 (CH_{Ar}), 113.86 (CH_{Ar}), 113.71 (CH_{Ar}), 64.02 (CH_{2-O}, major), 63.13 (CH_{2-O}, minor), 47.54 (CH_{2-N}), 46.77 (CH_{2}), 40.58 (CH_{2}), 31.08 (CH_{2}), 28.42 (2), 28.31 (bulk-CH_{2}), 25.61 (β), 21.98 (β-1), 16.55 (CH_{3}, major), 16.32 (CH_{3}, minor), 13.88 (CH_{3}); HRMS: m/z, [M+3–2H]–3Cl^− calcd. for C_{56}H_{79}N_{6}O_{6}^{5+}: 931.6061, found: 931.6144.

This compound was prepared analogously to 9b using tris-((2-chloro-acetamido)methyl)ethane (compound 3) (1.9 g, 5.43 mmol) and 1-benzyl-benzimidazole (7g) (3.39 g, 16.3 mmol) to provide a pale yellow hygroscopic semi-solid in 96% yield (5.08g). Molecular Formula: C_{53}H_{87}Cl_{3}N_{6}O_{6}; Mol. Wt.: 974.37; FTIR (cm^{-1}): 3120 (C-H), 2974 (C-H), 1750 (C=O), 1615 (C=N), 1562, 1486, 1455 (C=C), 1190, 1165 (C-O); 1H-NMR (400 MHz, DMSO-d_{6}) δ ppm: 10.30 (s, 3H, C=H_BImidazole, major), 10.23 (s, 3H, C=H_BImidazole, minor), 10.17 (s, 3H, C=H_BImidazole, minor), 8.05 (d, J=8.31 Hz, 3H, C=H_{Ar}), 7.99 (d, J=8.31 Hz, 3H, C=H_{Ar}), 7.63-7.51 (m, 12H, C=H_{Ar}), 7.41-7.31 (m, 9H, C=H_{Ar}), 5.89 (s, 6H, CH_{2-Ar}), 5.78 (s, 6H, O-CH_{2}, major), 5.74 (s, 6H, O-CH_{2}, minor), 5.67 (s, 6H, O-CH_{2}, minor), 4.03 (s, 6H, N-CH_{2}, major), 3.97 (s, 6H, N-CH_{2}, minor), 0.88 (s, 3H, CH_{3}, minor), 0.85 (s, 3H, CH_{3}, major); ^13C-NMR (100 MHz, DMSO-d_{6}) δ ppm: 167.19 (C=O, minor), 166.45 (C=O, major), 143.97 (C_BImidazole, minor), 143.66 (C_BImidazole, major), 133.93 (C_{Ar}-CH_{2}), 131.65 (C_BImidazole), 130.34 (C_BImidazole), 129.00 (2×CH_{Ar}), 128.77 (CH_{Ar}, major), 128.70 (CH_{Ar}, minor), 128.35 (2×CH_{Ar}), 126.90 (CH_BImidazole), 126.84 (CH_BImidazole), 114.20 (CH_BImidazole), 113.96 (CH_BImidazole), 66.36 (CH_{2-O}, major).
Tris-((N-butyl-imidazoliumy-acetoxyl)methyl)ethane bis(trifluoromethylsulfonyl)amide (10b)

This compound was prepared analogously to 10a using tris-((N-butyl-imidazoliumy-acetoxyl)methyl)-ethane chloride 8b (0.72 g, 1.0 mmole) and Lithium bis-(trifluoromethanesulphonyl)imide LiNTf₂ (1.0 g, 3.5 mmol) to provide a clear viscous hygroscopic liquid at room temperature in 85% yield (1.32 g). Molecular Formula: C₃₅H₃₈F₁₈N₅O₁₅S₆; Mol. Wt.: 1456.22; FTIR (cm⁻¹): 3055 (C-H)ₐr, 2970, 2935, 2872 (C-H)ₐlpb, 1743 (C=O), 1642 (C=N), 1560, 1466 (C=C)ₓr, 1351, 1223 (C-F), 1360, 1152 (O=S=O), 1195, 1163 (C-O); ¹H-NMR (400 MHz, CD₃OD) δ ppm: 8.97 (s, 3H, C-Hₓmidazole, minor), 8.94 (s, 3H, C-Hₓmidazole, major), 8.80 (s, 3H, C-Hₓmidazole, minor), 7.70 (s, 3H, C-Hₓmidazole, major), 7.50 (s, 3H, C-Hₓmidazole, minor), 5.20 (s, 6H, O-CH₂, major), 5.19 (s, 6H, O-CH₂, minor), 4.26 (t, J= 7.28 Hz, 6H, α-CH₂), 4.00 (s, 6H, N-CH₂, major), 4.16 (s, 6H, N-CH₂, minor), 1.80-1.73 (m, 6H, β-CH₂, major), 1.92-1.83 (m, 6H, β-CH₂), 1.42-1.33 (m, 6H, ±CH₂, 1.08 (s, 3H, CH₃), 0.98 (t, J =7.28 Hz, 9H, ω-CH₃); ¹³C-NMR (100 MHz, CD₃OD) δ ppm: 167.90 (C=O, minor), 167.77 (C=O, major), 138.67 (CHₓmidazole), 126.10, 122.91, 119.72, 116.54 (q, J=320, CF₁), 125.37 (CHₓmidazole), 123.69 (CHₓmidazole), 68.33 (CH₂-O, minor), 68.30 (CH₂-O, minor), 68.10 (CH₂-O, major), 50.87 (α-CH₂), 40.10 (-C-), 33.39 ((ω-2), minor), 33.15 ((ω-2), major), 20.61 ((α-1), minor), 20.52 ((ω-1), major), 17.04 (CH₃, major), 17.00 (CH₃, minor), 13.83 (α). ¹⁹F (336, MHz) δ ppm: –80.02; HRMS: m/z, [M⁺-2H]+3NTf₂ calcd. for C₃₂H₄₀N₆O₆⁵⁺: 613.3714, found: 613.3692; m/z, [NTf₂] calcd. for C₂F₆NO₃S₂⁺: 279.9173, found: 279.9175.

Tris-((N-hexyl-imidazoliumy-acetoxyl)methyl)ethane bis(trifluoromethylsulfonyl)amide (10c)

This compound was prepared analogously to 10a using tris-((N-hexyl-imidazoliumy-acetoxyl)methyl)-ethane chloride 8c (0.81 g, 1.0 mmole) and Lithium bis-(trifluoromethanesulphonyl)imide LiNTf₂ (1.0 g, 3.5 mmol) to provide a clear viscous hygroscopic liquid at room temperature in 85% yield (1.32 g). Molecular Formula: C₄₄H₄₁F₁₈N₅O₁₅S₆; Mol. Wt.: 1540.38; FTIR (cm⁻¹): 3062 (C-H)ₓr, 2970, 2931, 2845 (C-H)ₓlpb, 1749 (C=O), 1644 (C=N), 1564, 1460(C=C)ₓr, 1347, 1220 (C-F), 1366, 1153 (O=S=O), 1185, 1185 (C-O); ¹H-NMR (400 MHz, CD₃OD) δ ppm: 8.98 (bt-s, 3H, 3H, C-Hₓmidazole, minor), 8.97 (bt-s, 3H, 3H, C-Hₓmidazole, major), 8.39 (bt-s, 3H, 3H, C-Hₓmidazole, major), 7.69 (t, J=1.81 Hz, 3H, C-Hₓmidazole, major), 7.63 (t, J =1.81 Hz, 3H, C-Hₓmidazole, minor), 7.59 (t, J =1.81 Hz, 3H, C-Hₓmidazole, major), 5.19 (s, 6H, O-CH₂), 4.19 (s, J= 7.25 Hz, 6H, α-CH₂), 4.09 (s, 6H, N-CH₂, major), 4.14 (s, 6H, N-CH₂, minor), 1.93-1.86 (m, 6H, β-CH₂), 1.34 (bs, 18H, bulk-CH₂), 1.08 (s, 3H, CH₃), 0.99 (t, J =6.34 Hz, 9H, ω-CH₃); ¹³C-NMR (100 MHz, CD₃OD) δ ppm: 167.77 (C=O), 138.65 (CHₓmidazole), 126.15, 122.93, 119.71, 116.49 (q, J=320, CF₁), 125.37 (CHₓmidazole), 123.69 (CHₓmidazole), 68.23 (CH₂-O, minor), 68.15 (CH₂-O, major), 51.31 (CH₂-N), 50.89 (α-CH₂), 40.11 (-C-), 32.35 ((ω-2), 31.14 (bulk-CH₂), 26.99 (β-CH₂), 23.58 (α-1), 17.11 (CH₃, minor), 17.07 (CH₃, major), 14.38 (α). ¹⁹F (336, MHz) δ ppm: –80.22;

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HRMS: m/z, [M+13−2H]−3NTF2 calcd. for C38H31N6O5+S+: 697.4653, found: 697.4623; m/z, [NTF2]− calcd. for C2F6NO4S2−: 279.9173, found: 279.9177.

**Tris-((N-decyl-imidazoliumyl-acetayloxy)methyl)ethane bis(trifluoromethylsulfonyl)amide (10e)**

This compound was prepared analogously to 10a using tris-((N-decyl-imidazoliumyl-acetayloxy)methyl)-ethane chloride 8e (0.97 g, 1.0 mmole) and Lithium bis-(trifluoromethanesulphonylimide LiNTf2 (1.0 g, 3.5 mmol) to provide a clear viscous hygroscopic liquid at room temperature in 94% yield (1.6 g). Molecular Formula: C35H37N9O18S6; Mol. Wt.: 1708.70; FTIR (cm−1): 3058 (C-H)Ar, 2955, 2929, 2857 (C-H)Aliph, 1749 (C=O), 1666 (C=N), 1564, 1462 (C=C)Ar, 1340, 1210 (C-F), 1360, 1123 (O=S=O), 1199, 1165 (C-O); 1H-NMR (400 MHz, CD3OD) δ ppm: 9.00 (bt−s, 3H, C-Himidazoles, minor), 8.98 (bt−s, 3H, C-Himidazoles, major), 8.95 (bt−s, 3H, C-Himidazoles, major), 7.70 (t, J=1.81, 3H, C-Himidazoles, major), 7.65 (t, 3H, C-Himidazoles, major), 7.61 (t, J=1.81, 3H, C-Himidazoles, major), 7.56 (t, 3H, J=1.81, C-Himidazoles, minor), 7.51 (s, 6H, O-CH2, minor), 5.21 (s, 6H, O-CH2, major), 4.25 (t, J= 7.25 Hz, 6H, α-CH2), 4.21 (s, 6H, N-CH2), 1.94-1.87 (m, 6H, β-CH2), 1.33 (bs, 42H, bulk-CH2), 1.09 (s, 3H, CH3, major), 1.07 (s, 3H, CH3, minor), 0.90 (t, 9H, J =6.80 Hz, ω-CH3); 13C-NMR (100 MHz, CD3OD) δ ppm: 167.80 (C-O), 138.67 (CHimidazole), 126.17, 122.94, 119.71, 116.49 (q, J=321, CF3), 125.38 (CHimidazole), 123.70 (CHimidazole), 68.17 (CH2-O), 51.32 (CH2-N), 50.88 (α-CH2), 40.12 (-C-), 33.00 (ω-2), 31.20, 30.30 (2), 30.15 (2) (bulk-CH2), 27.33 (β), 23.80 (ω-1), 17.07 (CH3), 14.53 (ω). 19F (336, MHz) δ ppm: −80.52; HRMS: m/z, [M−80.12]−2HNTF2 calcd. for C36H35N7O17F4S3 calcd. for C38H31N6O5+S+: 697.4653, found: 697.4623; m/z, [NTF2]− calcd. for C2F6NO4S2−: 279.9173, found: 279.9148.

**Tris-((N-butyl-benzimidazoliumyl-acetayloxy)methyl)ethane bis(trifluoromethylsulfonyl)amide (11b)**

This compound was prepared analogously to 10a using tris-((N-butyl-benzimidazoliumyl-acetayloxy)methyl) ethane chloride 9b (0.87 g, 1.0 mmole) and Lithium bis-(trifluoromethanesulphonylimide LiNTf2 (1.0 g, 3.5 mmol) to provide a clear viscous hygroscopic liquid at room temperature in 84% yield (1.35 g). Molecular Formula: C35H37N9O18S6; Mol. Wt.: 1606.39; FTIR (cm−1): 3022 (C-H)Ar, 2950, 2942, 2863 (C-H)Aliph, 1755(C=O), 1618(C=N), 1564, 1485, 1469 (C=C)Ar, 1374, 1233 (C-F), 1354, 1169 (O=S=O), 1187, 1160 (C-O); 1H-NMR (400 MHz, DMSO-d6) δ ppm: 9.94 (s, 3H, C-HBimidazole, minor), 9.89 (s, 3H, C-HBimidazole, major), 9.82 (s, 3H, C-HBimidazole), 8.10-8.04 (m, 6H, CHAr, major), 7.27-7.22 (m, 6H, CHAr, minor), 5.65 (s, 6H, O-CH2, minor), 5.60 (s, 6H, O-CH2, major), 4.47 (t, J=7.07, 6H, ω-CH2, major), 4.27 (t, J=7.07, 6H, ω-CH2, minor), 4.01 (s, 6H, N-CH2, major), 3.98 (s, 6H, N-CH2, minor), 1.87-1.79 (m, 6H, β-CH2, major), 1.66-1.59 (m, 6H, β-CH2, minor), 1.28-1.18 (m, 6H, (ω-1)), 0.93 (s, 3H, CH3), 0.87 (t, 9H, J =7.21 Hz, ω-CH3); 13C-NMR (100 MHz, DMSO-d6) δ ppm: 166.76 (C-O), 144.03 (CHBimidazole, major), 143.867 (CHBimidazole, minor), 132.45 (CAr), 128.90 (CAr), 125.30, 122.09, 118.88, 115.67 (q, J=321, CF3), 125.02 (CAr), 124.14 (CAr), 112.85 (CAr), 110.17 (CAr), 68.03 (CH2-O), 46.55 (CH2-N), 44.03 (α-CH2, minor), 43.78 (α-CH2, major), 38.31 (ω-2), 32.17 (ω-2, minor), 31.90 (ω-2, major), 18.55 (ω-1, major), 17.95 (ω-1, minor), 15.74 (CH3), 13.23 (ω, minor), 13.12 (ω, major). 19F (336, MHz) δ ppm: −80.12; HRMS: m/z, [M+13−2H]−3NTF2 calcd. for
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C_{44}H_{82}N_{6}O_{6}^{5+}: 763.4183, found: 763.4202; m/z, [NTF2] calcd. for C_{2}F_{6}NO_{5}S_{2}^{-}: 279.9173, found: 279.9209.

Tris-((N-decyl-benzimidazoliumyl-acetoxylmethyl)ethyl)ethane bis(trifluoromethylsulfonyl)-amide (11e)

This compound was prepared analogously to 10a using tris-((N-decyl-benzimidazoliumyl-acetoxylmethyl)ethyl)ethane chloride 9e (1.12 g, 1.0 mmole) and Lithium bis-(trifluoromethanesulphonylimide LiNTf2 (1.0 g, 3.5 mmol) to provide a clear viscous hygroscopic liquid at room temperature in 90% yield (1.67 g). Molecular Formula: C_{68}H_{82}F_{18}N_{7}O_{18}S_{6}; Mol. Wt.: 1858.88; FTIR (cm^-1): 3130 (C-H)\_Ar, 2949, 2924, 2848 (C-H)\_Aliph, 1749 (C=O), 1620 (C=N), 1566 1485, 1457 (C=C)\_Ar, 1367, 1223 (C-F), 1360, 1165 (O=S=O), 1218, 1199 (C-O); 1H-NMR (400 MHz, CD_{3}OD) δ ppm: 9.54 (s, 3H, C-H\_Bimidazole, minor), 9.48 (s, 3H, C-H\_Bimidazole, major), 8.02-7.82 (m, 6H, CH\_Ar), 7.73-7.55 (m, 6H, CH\_Ar), 5.51 (s, 6H, O-CH\_2), 5.50 (s, 6H, O-CH\_2, minor), 5.48 (s, 6H, O-CH\_2, major), 4.57 (t, J=7.20, 6H, α-CH\_2, major), 4.50 (t, J=7.20, 6H, α-CH\_2, minor), 4.21 (s, 6H, N-CH\_2, major), 4.19 (s, 6H, N-CH\_2, minor), 4.17 (s, 6H, N-CH\_2, minor), 2.04-1.94 (m, 6H, β-CH\_2), 1.27 (bs, 42H, bulk-CH\_2), 1.04 (s, 3H, CH\_3, major), 1.02 (s, 3H, CH\_3, minor), 0.88 (t, 9H, J=6.78, ω-CH\_3); 13C-NMR (100 MHz, CD_{3}OD) δ ppm: 167.66 (C=O, major), 167.57 (C=O, minor), 144.05 (CH\_Bimidazole), 133.31 (C\_Ar), 132.57 (C\_Ar), 128.78 (CH\_Ar), 128.60 (CH\_Ar), 126.17, 122.95, 119.73, 116.51 (q, J=320, CF\_3), 114.79 (2) (CH\_Ar), 68.07 (CH\_2-O, minor), 67.85 (CH\_2-O, major), 46.69 (CH\_2-N), 41.89 (α-CH\_3, minor), 41.70 (α-CH\_3, minor), 40.50 (α-C), 33.17 (ω-2), 30.72, 30.65, 30.54, 30.25 (2) (bulk-CH\_2), 27.58 (β), 23.85 (ω-1), 17.07 (CH\_3, minor), 16.97 (CH\_3, major), 14.58 (ω). 19F (336, MHz) δ ppm: -80.06; HRMS: m/z, [M^{3-2H}–3NTF2] calcd. for C_{62}H_{84}N_{6}O_{6}^{5+}: 1015.7000, found: 1015.6977; m/z, [NTF2] calcd. for C_{2}F_{6}NO_{5}S_{2}^{-}: 279.9173, found: 279.9175.

Tris-((N-dodecyl-benzimidazoliumyl-acetoxylmethyl)ethyl)ethane bis(trifluoromethylsulfonyl)-amide (11f)

This compound was prepared analogously to 10a using tris-((N-dodecyl-benzimidazoliumyl-acetoxylmethyl)ethyl)ethane chloride 9f (1.21 g, 1.0 mmole) and Lithium bis-(trifluoromethanesulphonylimide LiNTf2 (1.0 g, 3.5 mmol) to provide a clear viscous hygroscopic liquid at room temperature in 96% yield (1.87 g). Molecular Formula: C_{74}H_{105}F_{18}N_{7}O_{18}S_{6}; Mol. Wt.: 1943.04; FTIR (cm^-1): 3127 (C-H)\_Ar, 2965 (C-H)\_Aliph, 1750 (C=O), 1622 (C=N), 1565, 1485, 1448 (C=C)\_Ar, 1362, 1222 (C-F), 1358, 1167 (O=S=O), 1210, 1170 (C-O); 1H-NMR (400 MHz, CD_{3}OD) δ ppm: 9.72 (s, 3H, C-H\_Bimidazole, minor), 9.69 (s, 3H, C-H\_Bimidazole, minor), 9.65 (s, 3H, C-H\_Bimidazole, major), 8.00-7.91 (m, 6H, C-H\_Bimidazole), 7.71-7.54 (m, 6H, C-H\_Ar, major), 7.40-7.31 (m, 6H, C-H\_Ar, minor), 5.60 (s, 6H, O-CH\_2, major), 5.57 (s, 6H, O-CH\_2, minor), 4.53 (t, J=7.07, 6H, α-CH\_2, major), 4.34 (t, J=7.07, 6H, α-CH\_2, minor), 4.19 (s, 6H, N-CH\_2, major), 4.16 (s, 6H, N-CH\_2, minor), 1.98-1.92 (m, 6H, β-CH\_2), 1.24 (bs, 54H, bulk-CH\_2), 1.03 (s, 3H, CH\_3, minor), 1.00 (s, 3H, CH\_3, minor), 0.97 (s, 3H, CH\_3, major), 0.86 (t, J=7.25, 9H, ω-CH\_3); 13C-NMR (100 MHz, CD_{3}OD) δ ppm: 166.89 (C=O), 143.75 (CH\_Bimidazole, major), 143.51(CH\_Bimidazole, minor), 133.10 (CH\_Bimidazole), 130.92 (CH\_Bimidazole), 128.08 (CH\_Ar), 127.12 (CH\_Ar), 126.36, 123.14, 119.92, 116.71 (q, J=320, CF\_3), 114.81 (CH\_Ar), 114.76 (CH\_Ar), 68.37 (CH\_2-O, minor), 68.24 (CH\_2-O, major), 45.70 (CH\_2-N), 40.18 (α-CH\_2), 39.34 (ω-2), 31.65 (ω-2), 29.66 (2), 29.32, 29.22, 29.03, 28.93, 28.86 (bulk-CH\_2), 25.82 (β),
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22.53 (ω-1), 16.23 (CH₃, minor), 16.03 (CH₂, major), 14.19 (ω). ¹⁹F (336, MHz) δ ppm: −80.20; HRMS: m/z, [M⁺–2H]−3NTF₂ calcd. for C₆₈H₁₀₃N₆O₆⁵⁺: 1099.7939, found: 1099.7977; m/z, [NTF₂] calcd. for C₂F₆NO₄S₂⁻: 279.9173, found: 279.9225.

Tris-((N-benzyl-benzimidazoliumyl-acetayloxy)methyl)ethane bis(trifluoromethylsulfonyl)-amide (11g)

This compound was prepared analogously to 10a using tris-((N-benzyl-benzimidazoliumyl-acetayloxy)methyl)ethane chloride 9g (0.97 g, 1.0 mmole) and Lithium bis-(trifluoromethanesulphonyl)imide LiNTf₂ (1.0 g, 3.5 mmol) to provide a clear viscous hygroscopic liquid at room temperature in 96% yield (1.63 g). Molecular Formula: C₅₉H₅₁F₁₈N₉O₁₈S₆; Mol. Wt.: 1708.45; FTIR (cm⁻¹): 3127 (C-H) Ar, 2965 (C-H) Aliph, 1750 (C=O), 1622 (C=N), 1565, 1485, 1448 (C=C), 1362, 1222 (C-F), 1358, 1167 (O=S=O), 1210, 1170 (C-O); ¹H-NMR (400 MHz, DMSO-d₆) δ ppm: 10.44 (s, 3H, C-H BImidazole, major), 10.30  (s, 3H, C-H BImidazole, minor), 10.13 (s, 3H, C-H BImidazole, minor), 8.12-8.00 (m, 6H, C-H Ar), 7.61-7.53 (m, 12H, C-H Ar), 7.39-7.22 (m, 9H, C-H Ar), 5.92 (s, 6H, O-CH₂, major), 5.84 (s, 6H, O-CH₂, major), 5.79 (s, 6H, O-CH₂, minor), 4.04 (s, 6H, N-CH₂, major), 3.99 (s, 6H, N-CH₂, minor), 0.91 (s, 3H, CH₃, minor), 0.86 (s, 3H, CH₃, minor), 0.82 (s, 3H, CH₃, major); ¹³C-NMR (100 MHz, DMSO-d₆) δ ppm: 168.01 (C=O, major), 166.57 (C=O, minor), 143.48 (CH BImidazolyl, major), 142.82 (CH BImidazolyl, minor), 133.82 (CH Ar CH₂), 131.79 (CH BImidazole), 130.48 (CH BImidazole), 129.10 (2×CH Ar), 128.87 (CH Ar), 128.31 (2×CH Ar), 126.98 (CH BImidazole), 126.81 (CH BImidazole), 124.37, 121.13, 117.90, 114.66 (q, J=322, CF₃), 114.06 (CH BImidazole), 113.89 (CH BImidazole), 63.33 (CH₂-O, major), 62.67 (CH₂-O, minor), 50.00 (CH₂-N), 47.72 (Ar-CH₂, major), 47.61 (Ar-CH₂, major), 40.63 (-C-), 16.33 (CH₃, major), 16.08 (CH₃, minor). ¹⁹F (336, MHz) δ ppm: −79.95; HRMS: m/z, [M⁺–2H]−3NTF₂ calcd. for C₆₈H₁₀₃N₆O₆⁵⁺: 865.3714, found: 865.3750; m/z, [NTF₂] calcd. for C₂F₆NO₄S₂⁻: 279.9173, found: 279.9214.