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## SUPPORTING INFORMATION

Scalable and robust silica aerogel materials from ambient pressure drying

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**Figure S1.** a) and b) Element mapping (Energy Dispersive Spectroscopy- EDS) analysis for aerogel samples including waterglass before and after ion-exchange procedure, alongside optical images showing macroscopic morphology of aerogels for both cases.



**Figure S2.** Thermal conductivity vs sintering temperature for aerogel samples with 1:1 SDS/CTAB ratio and different urea molar ratio and ion-exchange waterglass weight percentage respectively.



**Figure S3.** Thermal conductivity and porosity vs urea molar ratio for aerogel samples with 1:1 SDS/CTAB ratio and 25% weight ion-exchange waterglass respectively.



**Figure S4.** BET specific surface area and porosity vs urea molar ratio for aerogel samples with 1:1 SDS/CTAB ratio and 25% weight ion-exchange waterglass.





**Figure S6.** X-ray diffraction (XRD) spectra for aerogel samples with 1:1 SDS/CTAB ratio and 25% weight ion-exchange waterglass, including 4.125 and 6.875 mol/L of urea respectively. Both specimens feature an amorphous nature as suggested by the broad peak observed near 22° as shown, while the small difference between both patterns can be attributed to a dissimilar structural evolution of Si and C prior to the formation of SiC during condensation, due to gradual reaction between both C and Si respectively.



Figure S7. X-ray diffraction (XRD) spectra for aerogel samples with 6.875 mol/L of urea and 25% weight ion-exchange waterglass, including different SDS/CTAB molar ratios.



Figure S8. Optical image of aerogel precursor without (a) and with (b) urea after 24 hours into gelation stage. Inset images include pH measurement of the precursor.

| а            |   |   |  |  |  |  |   | h |  |   |  |   |   |
|--------------|---|---|--|--|--|--|---|---|--|---|--|---|---|
| WATERGLASS   |   |   |  |  |  |  |   | U |  | 「たいのない」   |  |   |   |
|              | L.  | 50  | <u>n</u> m   |  |  |  |   |   |  | 50  | nw.  |   |   |
| Ĺ            | abel  | 50<br>Area  | Mean   | Min  | Max  | Angle  | Length  | [ | Label  | Area  | Mean   | Min   | Max   |
| L            | _abel<br>P1   | 50<br>Area<br>2.541   | Mean<br>101.113  | Min<br>43.299  | Max<br>251   | Angle<br>-12.265   | Length<br>10.83   |   | Label<br>P1  | Area<br>1.801   | Mean<br>69.259   | Min<br>16.875   | Max<br>142  |
| Ļ            | _abel<br>P1<br>P2   | Area<br>2.541<br>2.064  | Mean<br>101.113<br>94.862  | Min<br>43.299<br>52.82   | Max<br>251<br>134.064  | Angle<br>-12.265<br>-12.2  | Length<br>10.83<br>8.709  |   | Label<br>P1<br>P2  | Area<br>1.801<br>1.856  | Mean<br>69.259<br>42.324   | Min<br>16.875<br>10   | Max<br>142<br>96  |
|              | _abel<br>P1<br>P2<br>P3   | Area<br>2.541<br>2.064<br>1.641   | Mean<br>101.113<br>94.862<br>61.092  | Min<br>43.299<br>52.82<br>9.333  | Max<br>251<br>134.064<br>154.8   | Angle<br>-12.265<br>-12.2<br>88.091  | Length<br>10.83<br>8.709<br>6.906   |   | Label<br>P1<br>P2<br>P3  | Area<br>1.801<br>1.856<br>1.801   | Mean<br>69.259<br>42.324<br>52.4   | Min<br>16.875<br>10<br>20.375   | Max<br>142<br>96<br>112.844   |
|              | Label<br>P1<br>P2<br>P3<br>P4   | Area<br>2.541<br>2.064<br>1.641<br>2.17   | Mean<br>101.113<br>94.862<br>61.092<br>33.706  | Min<br>43.299<br>52.82<br>9.333<br>0   | Max<br>251<br>134.064<br>154.8<br>68   | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862  | Length<br>10.83<br>8.709<br>6.906<br>9.214  |   | Label<br>P1<br>P2<br>P3<br>P4  | Area<br>1.801<br>1.856<br>1.801<br>2.511  | Mean<br>69.259<br>42.324<br>52.4<br>60.775   | Min<br>16.875<br>10<br>20.375<br>32.852   | Max<br>142<br>96<br>112.844<br>87.339   |
|              | _abel<br>P1<br>P2<br>P3<br>P4<br>P5   | Area<br>2.541<br>2.064<br>1.641<br>2.117<br>2.117   | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974  | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>21.826   | Max<br>251<br>134.064<br>154.8<br>68<br>134.789  | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325   | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984   |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5  | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965   | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269   | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016  | Max<br>142<br>96<br>112.844<br>87.339<br>135  |
|              | abel<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6  | Area<br>2.541<br>2.064<br>1.641<br>2.17<br>2.117<br>1.482   | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>1117.729  | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951   | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963   | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799   | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>0.202   |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6  | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>4.500  | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388   | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259  | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>700  |
|              | _abel<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P2   | Area<br>2.541<br>2.064<br>1.641<br>2.17<br>2.117<br>1.482<br>1.641  | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>404.734   | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>00.40  | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>470.420   | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381   | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>6.829<br>9.000  |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7  | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>4.343   | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>96.442   | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>0  | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79   |
|              | abel<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P7<br>P8  | Area<br>2.541<br>2.064<br>1.641<br>2.17<br>2.117<br>1.482<br>1.641<br>2.276   | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>101.734  | Min<br>43.299<br>52.82<br>9.333<br>0<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>99.244  | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>734  | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381<br>-1.364<br>5.404  | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>6.829<br>9.665<br>12.705  |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P0  | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.265  | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>86.942<br>409.957  | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>54   | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>104.657   |
|              | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10  | Area<br>2.541<br>2.064<br>1.641<br>2.17<br>2.117<br>1.482<br>1.641<br>2.276<br>2.964<br>2.964   | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>101.734<br>124.106<br>491.92   | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>88.364<br>412.24   | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>221<br>245.544   | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381<br>-1.364<br>-5.194<br>402.671  | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>6.829<br>9.665<br>12.705<br>9.76  |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P8<br>P9<br>P10   | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.365<br>2.511   | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>86.942<br>129.867<br>01.999  | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>54<br>41.122   | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>184.667<br>79   |
| <br><br><br> | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11   | Area<br>2.541<br>2.064<br>1.641<br>2.17<br>2.117<br>1.482<br>1.641<br>2.276<br>2.964<br>2.964   | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>124.106<br>181.93<br>132.932   | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>88.364<br>112.84<br>104.587  | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>221<br>245.544<br>188.851  | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381<br>-1.364<br>-5.194<br>103.671<br>-68.839   | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>6.113<br>6.829<br>9.665<br>12.705<br>8.76<br>8.76   |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11  | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.365<br>2.511<br>1.638  | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>86.942<br>129.867<br>91.889<br>9123.115  | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>54<br>41.173<br>56   | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>184.667<br>163.507<br>125.095   |
|              | abel<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P12   | Area<br>2.541<br>2.064<br>1.641<br>2.17<br>1.482<br>1.641<br>2.276<br>2.964<br>2.064<br>1.8<br>2.064  | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>124.106<br>181.93<br>132.932   | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>88.364<br>112.84<br>104.587<br>26  | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>221<br>245.544<br>188.851<br>1400  | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>-109.799<br>57.381<br>-1.364<br>-5.194<br>103.671<br>-68.839<br>0   | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.884<br>6.113<br>6.829<br>9.665<br>12.705<br>8.76<br>7.648<br>8.972  |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P12   | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.365<br>2.511<br>1.638<br>2.238   | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>86.942<br>129.867<br>91.889<br>123.115<br>70.018   | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>41.173<br>56<br>32.45  | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>184.667<br>163.507<br>185.095<br>125  |
|              | abel<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P12<br>P13                                      | Area<br>2.541<br>2.064<br>1.641<br>2.177<br>2.117<br>1.482<br>1.641<br>2.276<br>2.964<br>2.064<br>1.8<br>2.117<br>2.234   | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>124.106<br>181.93<br>132.932<br>86<br>163.466  | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>88.364<br>112.84<br>104.587<br>26<br>124.004   | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>221<br>245.544<br>188.851<br>140<br>233.795  | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381<br>-1.364<br>-5.194<br>103.671<br>-68.839<br>0<br>14.036  | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>6.829<br>9.665<br>12.705<br>8.76<br>7.648<br>8.972<br>9.486                                       |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P11<br>P12<br>P13   | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.365<br>2.511<br>1.638<br>2.238<br>2.184  | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>129.867<br>91.889<br>123.115<br>70.018<br>116.451  | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>41.173<br>56<br>32.45<br>68.775<br>68.775                                    | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>184.667<br>163.507<br>185.095<br>125<br>125<br>124<br>527<br>164<br>527<br>164<br>527<br>164<br>527<br>165<br>165<br>165<br>165<br>165<br>165<br>165<br>165   |
|              | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P11<br>P12<br>P13<br>P14                       | Area<br>2.541<br>2.064<br>1.641<br>2.117<br>1.482<br>1.641<br>2.964<br>2.964<br>1.8<br>2.117<br>2.223<br>2.488  | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>124.106<br>181.93<br>132.932<br>86<br>163.466<br>124.884                                       | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>88.364<br>112.84<br>104.587<br>26<br>124.004<br>58 97                                    | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>221<br>178.476<br>221<br>178.476<br>223.795<br>223.577                                       | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381<br>-1.364<br>-5.194<br>103.671<br>-68.839<br>0<br>14.036<br>-17.65  | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>6.829<br>9.665<br>12.705<br>8.76<br>7.648<br>8.972<br>9.486<br>10.623                             |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P11<br>P12<br>P14   | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.365<br>2.511<br>1.638<br>2.238<br>2.184<br>1.638                                     | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>86.942<br>129.867<br>91.889<br>123.115<br>70.018<br>116.451<br>84.019                                | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>54<br>41.173<br>56<br>32.45<br>68.775<br>50.737                              | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>184.667<br>163.507<br>185.095<br>125<br>164.527<br>133.206  |
|              | abel<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P12<br>P13<br>P14<br>P15                        | Area<br>2.541<br>2.064<br>1.641<br>2.17<br>2.117<br>1.482<br>1.641<br>2.276<br>2.964<br>2.064<br>1.88<br>2.117<br>2.223<br>2.488<br>1.852                           | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>124.106<br>181.93<br>132.932<br>86<br>163.466<br>163.466<br>124.884<br>54.43                   | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>88.364<br>112.84<br>112.84<br>104.587<br>26<br>124.004<br>58.97<br>25.508                | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>221<br>245.544<br>188.851<br>140<br>223.795<br>223.577<br>120.799                            | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381<br>-1.364<br>-5.194<br>103.671<br>-68.839<br>0<br>14.036<br>-17.65<br>-142.125                                | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>6.829<br>9.665<br>12.705<br>8.76<br>8.972<br>9.486<br>8.972<br>9.486<br>10.623<br>7.869           |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P12<br>P13<br>P14<br>P15                                  | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.365<br>2.511<br>1.638<br>2.238<br>2.184<br>1.638<br>1.529                            | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>86.942<br>129.867<br>91.889<br>123.115<br>70.018<br>116.451<br>84.019<br>149.501                     | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>54<br>41.173<br>56<br>32.45<br>68.775<br>50.737<br>94.667                    | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>184.667<br>163.507<br>185.095<br>125<br>164.527<br>133.206<br>242.481   |
|              | abel<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P11<br>P12<br>P13<br>P14<br>P15<br>Mean         | Area<br>2.541<br>2.064<br>1.641<br>2.177<br>2.117<br>1.482<br>1.641<br>2.276<br>2.964<br>2.064<br>1.8<br>2.117<br>2.223<br>2.488<br>1.852<br>2.096                  | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>124.106<br>181.93<br>132.932<br>866<br>163.466<br>124.884<br>54.43<br>106.72                   | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>88.364<br>112.84<br>104.587<br>26<br>124.004<br>58.97<br>25.508<br>58.821                | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>221<br>245.544<br>178.476<br>223.795<br>223.577<br>120.799<br>178.696                        | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381<br>-1.364<br>-5.194<br>103.671<br>-68.839<br>0<br>14.036<br>-17.65<br>-142.125<br>5.995                       | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>6.829<br>9.665<br>12.705<br>8.76<br>7.648<br>8.972<br>9.486<br>10.623<br>7.869<br>8.888           |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P7<br>P8<br>P9<br>P10<br>P11<br>P11<br>P12<br>P13<br>P14<br>P15<br>Mean             | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.365<br>2.511<br>1.638<br>2.238<br>2.184<br>1.638<br>1.529<br>1.892<br>1.892          | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>129.867<br>91.889<br>123.115<br>70.018<br>116.451<br>84.019<br>149.501<br>83.043                     | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>41.173<br>56<br>32.45<br>68.775<br>50.737<br>94.667<br>36.244                | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>184.667<br>185.095<br>125<br>164.527<br>133.206<br>125<br>164.527<br>133.206<br>125<br>164.527<br>133.206<br>125<br>164.527<br>133.206<br>125<br>164.527<br>133.206<br>125<br>164.527<br>133.206<br>125<br>164.527<br>133.206<br>125<br>164.527<br>133.206<br>125<br>164.527<br>133.206<br>125<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>135<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.527<br>164.577<br>164.577<br>164.577<br>164.577<br>164.577<br>164.577<br>164.577<br>164.577<br>164.577<br>164.577<br>164.5777<br>164.5777<br>164.5777<br>164.57777<br>164.57777<br>164.577777<br>164.5777777777777777777777777777777777777 |
|              | abel   P1   P2   P3   P4   P5   P6   P7   P8   P9   P10   P11   P12   P13   P14   P15   Mean   SD                           | Area<br>2.541<br>2.064<br>1.641<br>2.177<br>2.117<br>1.482<br>1.641<br>2.276<br>2.964<br>2.064<br>1.8<br>2.117<br>2.223<br>2.488<br>1.852<br>2.096<br>0.387         | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>124.106<br>181.93<br>132.932<br>86<br>163.466<br>124.884<br>54.43<br>106.72<br>40.63           | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>88.364<br>112.84<br>104.587<br>26<br>124.004<br>58.97<br>25.508<br>58.821<br>38.185      | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>221<br>245.544<br>188.851<br>140<br>223.795<br>223.577<br>120.799<br>178.696<br>53.289       | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381<br>-1.364<br>-5.194<br>103.671<br>-68.839<br>0<br>0<br>14.036<br>-17.65<br>-142.125<br>5.995<br>74.829        | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>6.829<br>9.665<br>12.705<br>8.76<br>7.648<br>8.972<br>9.486<br>10.623<br>7.869<br>8.888<br>1.71   |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P12<br>P13<br>P14<br>P13<br>P14<br>P15<br>Mean<br>SD      | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.365<br>2.518<br>2.184<br>1.638<br>2.238<br>2.184<br>1.638<br>1.529<br>1.892<br>0.345 | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>86.942<br>129.867<br>91.889<br>123.115<br>70.018<br>116.451<br>84.019<br>149.501<br>83.043<br>33.938 | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>41.173<br>56<br>32.45<br>32.45<br>50.737<br>94.667<br>36.244<br>26.252       | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>184.667<br>163.507<br>185.095<br>125<br>164.527<br>133.206<br>242.481<br>148.094<br>45.605  |
|              | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P9<br>P10<br>P11<br>P11<br>P12<br>P13<br>P14<br>P15<br>Mean<br>Sin | Area<br>2.541<br>2.064<br>1.641<br>2.17<br>2.177<br>1.482<br>1.641<br>2.276<br>2.964<br>2.964<br>1.8<br>2.117<br>2.223<br>2.488<br>1.852<br>2.096<br>0.387<br>1.482 | Mean<br>101.113<br>94.862<br>61.092<br>33.706<br>79.974<br>117.729<br>142.843<br>101.734<br>124.106<br>181.93<br>132.932<br>86<br>163.466<br>124.884<br>54.43<br>106.72<br>40.63<br>33.706 | Min<br>43.299<br>52.82<br>9.333<br>0<br>21.826<br>67.951<br>77.2<br>69.619<br>88.364<br>112.84<br>104.587<br>26<br>124.004<br>58.97<br>25.508<br>58.821<br>38.185<br>0 | Max<br>251<br>134.064<br>154.8<br>68<br>134.789<br>167.963<br>227.778<br>178.476<br>221<br>245.544<br>188.851<br>140<br>223.795<br>223.577<br>120.799<br>178.696<br>53.289<br>68 | Angle<br>-12.265<br>-12.2<br>88.091<br>92.862<br>103.325<br>-109.799<br>57.381<br>-1.364<br>-5.194<br>103.671<br>-68.839<br>0<br>14.036<br>-17.65<br>-142.125<br>5.995<br>74.829<br>-142.125 | Length<br>10.83<br>8.709<br>6.906<br>9.214<br>8.984<br>6.113<br>6.829<br>9.665<br>12.705<br>8.764<br>8.872<br>9.486<br>10.623<br>7.869<br>8.888<br>1.711<br>6.113 |   | Label<br>P1<br>P2<br>P3<br>P4<br>P5<br>P6<br>P7<br>P8<br>P7<br>P8<br>P7<br>P10<br>P11<br>P12<br>P13<br>P14<br>P15<br>Mean<br>SD<br>Min | Area<br>1.801<br>1.856<br>1.801<br>2.511<br>1.965<br>2.02<br>1.583<br>1.747<br>1.365<br>2.511<br>1.638<br>2.288<br>2.184<br>1.638<br>1.529<br>1.892<br>0.345<br>1.365 | Mean<br>69.259<br>42.324<br>52.4<br>60.775<br>50.269<br>82.388<br>36.432<br>129.867<br>91.889<br>123.115<br>70.018<br>116.451<br>84.019<br>149.501<br>83.043<br>33.938<br>36.432 | Min<br>16.875<br>10<br>20.375<br>32.852<br>8.016<br>47.259<br>0<br>10.484<br>41.173<br>56<br>32.45<br>68.775<br>50.737<br>94.667<br>36.244<br>26.252<br>0 | Max<br>142<br>96<br>112.844<br>87.339<br>135<br>165<br>79<br>205.742<br>184.667<br>163.507<br>185.095<br>125<br>164.527<br>164.527<br>133.206<br>242.481<br>148.094<br>45.605<br>79   |

NON-ION-EXCHANGE

|       | 12.00 |         |         |         |          |        |
|-------|-------|---------|---------|---------|----------|--------|
| Label | Area  | Mean    | Min     | Max     | Angle    | Length |
| P1    | 2.541 | 101.113 | 43.299  | 251     | -12.265  | 10.83  |
| P2    | 2.064 | 94.862  | 52.82   | 134.064 | -12.2    | 8.709  |
| P3    | 1.641 | 61.092  | 9.333   | 154.8   | 88.091   | 6.906  |
| P4    | 2.17  | 33.706  | 0       | 68      | 92.862   | 9.214  |
| P5    | 2.117 | 79.974  | 21.826  | 134.789 | 103.325  | 8.984  |
| P6    | 1.482 | 117.729 | 67.951  | 167.963 | -109.799 | 6.113  |
| P7    | 1.641 | 142.843 | 77.2    | 227.778 | 57.381   | 6.829  |
| P8    | 2.276 | 101.734 | 69.619  | 178.476 | -1.364   | 9.665  |
| P9    | 2.964 | 124.106 | 88.364  | 221     | -5.194   | 12.705 |
| P10   | 2.064 | 181.93  | 112.84  | 245.544 | 103.671  | 8.76   |
| P11   | 1.8   | 132.932 | 104.587 | 188.851 | -68.839  | 7.648  |
| P12   | 2.117 | 86      | 26      | 140     | 0        | 8.972  |
| P13   | 2.223 | 163.466 | 124.004 | 223.795 | 14.036   | 9.486  |
| P14   | 2.488 | 124.884 | 58.97   | 223.577 | -17.65   | 10.623 |
| P15   | 1.852 | 54.43   | 25.508  | 120.799 | -142.125 | 7.869  |
| Mean  | 2.096 | 106.72  | 58.821  | 178.696 | 5.995    | 8.888  |
| SD    | 0.387 | 40.63   | 38.185  | 53.289  | 74.829   | 1.71   |
| Min   | 1.482 | 33.706  | 0       | 68      | -142.125 | 6.113  |
| Max   | 2.964 | 181.93  | 124.004 | 251     | 103.671  | 12.705 |

Figure S9. TEM images of silica aerogel powder (sintered to 600 °C) synthesized without (a) and with (b) ionexchange waterglass. The results in the table correspond to Particle Size Analysis using image analysis software. **ION-EXCHANGE WATERGLASS** 

Length 1 7.567 ) 7.71

7.466 10.579

8.257

8.32

6.579 7.258 5.627

10.493

6.824

9.45 9.028

6.743 6.313

7.881 1.477 5.627 10.579

Angle

-8.881 0

20.136

-115.115

38.157

-96.116 176.309

48.366

168.44

51.953

-8.531 -169.563 -75.964

2.121

-0.793

94.635 -169.563

176.309



**Figure S10.** (a) Strain-stress plot for tensile test to low strain rate for elastic modulus calculation; (b) Strain-stress plot for tensile test to low strain rate for tensile strength calculation; (c) Tensile strength comparison for cellulose-fiber-based materials using three different precursors; and (d) Strain-stress plot for flexural (bending) tests for flexural strength and flexural modulus calculations.

| CO-SURFACTANT<br>RATIO | k<br>(₩/ m · K) | BET SURF.<br>AREA<br><i>(m²/g)</i> | BJH DESORPTION<br>AVG. PORE WIDTH<br>(nm) | AVERAGE<br>PARTICLE SIZE<br>(nm) | POROSITY<br>(%) |
|------------------------|-----------------|------------------------------------|---|----------------------------------|-----------------|
| 1:1                    | 0.0275          | 399.23                             | 6.642                                     | 15.029                           | 89.4            |
| 1:2                    | 0.0234          | 412.84                             | 13.678                                    | 14.534                           | 97.4            |
| 2:1                    | 0.0336          | 271.96                             | 17.980                                    | 22.062                           | 85.0            |
| 1:3                    | 0.0242          | 498.03                             | 9.449                                     | 12.048                           | 98.3            |
| 3:1                    | 0.0380          | 331.38                             | 12.731                                    | 18.106                           | 82.7            |
| 1:5                    | 0.0263          | 507.56                             | 18,922                                    | 11.821                           | 92.5            |
| CTAB ONLY              | 0.0353          | 541.56                             | 10.303                                    | 11.079                           | 84.4            |

**Table S1.**Properties of aerogel specimens with 6.875 mol/L of urea and 25% weight ion-<br/>exchange waterglass, (including different SDS/CTAB molar ratios)

**Table S2.** Properties of cellulose fiber/silica aerogel composite specimens following mechanical properties tests<br/>(uniaxial compression, tensile, and flexural tests).

|                              | THICKNESS<br>(mm) | wt%<br>AEROGEL<br>(%) | <b>k</b><br>(W· m⁻¹ · K⁻¹) | UNIAXIAL COMPR   | ESSION TEST                                  | TENSIL                                     | E TEST                                   | FLEXURAL TEST                               |                              |
|------------------------------|-------------------|-----------------------|----------------------------|--|--|--|--|---|------------------------------|
| AEROGEL<br>PRECURSOR         |                   |                       |                            | MAX. COMPRESSIVE<br>STRESS<br>(AT 50% STRAIN)<br>(kPa) | ELASTIC<br>MODULUS<br>(COMPRESSIVE)<br>(MPa) | ULTIMATE<br>STRENGTH<br>(TENSILE)<br>(kPa) | ELASTIC<br>MODULUS<br>(TENSILE)<br>(MPa) | ULTIMATE<br>STRENGTH<br>(FLEXURAL)<br>(kPa) | FLEXURAL<br>MODULUS<br>(MPa) |
| 1:1 SDS/CTAB                 | 3.1               | ~ 49                  | 0.0451                     | 9821.66  | 6.02   | 1313.0                                     | 12.17                                    | 1866.6                                      | 113.3                        |
| 1:2 SDS/CTAB                 | 3.4               | ~ 55                  | 0.0365                     | 11079.28   | 13.51  | 465.6                                      | 10.03                                    | 811.2                                       | 57.9                         |
| CTAB ONLY                    | 2.7               | ~ 44                  | 0.0324                     | 10432.98   | 8.59   | 445.7                                      | 7.58                                     | 608.6                                       | 39.2                         |
| 1:2 SDS/CTAB<br>(MONOLITHIC) | 4.5               | 100                   |                            | 1405<br>(BEFORE FRACTURING)                            | 10.84  |  |  |   |                              |