

Effect of Functionalized Multiwalled Carbon Nanotubes on Mechanical, Swelling and Viscoelastic Properties on Gum ghatti-*cl*-poly(NIPAm) Hydrogels

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Supplementary information

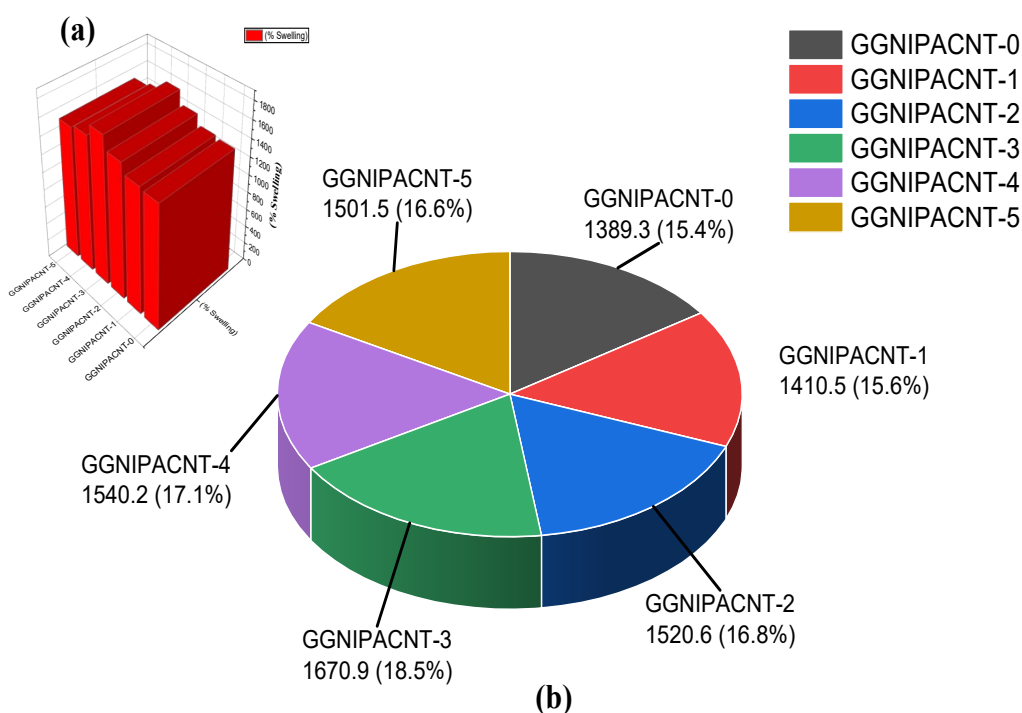


Figure S1 Percentage swelling of Gum ghatti-*cl*-poly(NIPAm)-*o*-MWCNT hydrogels.

Table S1. Effect of *-o*-MWCNT concentration on the viscosity of GGNIPACNT hydrogels at different shear rates.

| <i>-o</i> -MWCNT conc. (mg) | Viscosity at Shear rate (1/s) | | | |
|--------------------------------|-------------------------------|------|------|------|
| | 0.1 | 1 | 10 | 100 |
| 0 | 142 | 27.4 | 5.12 | 1.31 |
| 10 | 85.7 | 41.4 | 7.51 | 1.8 |
| 20 | 324 | 60.1 | 12 | 3.53 |
| 30 | 324 | 60.1 | 12 | 3.53 |
| 40 | 341 | 56.4 | 9.62 | 2.66 |
| 50 | 83.5 | 36.8 | 7.2 | 1.7 |

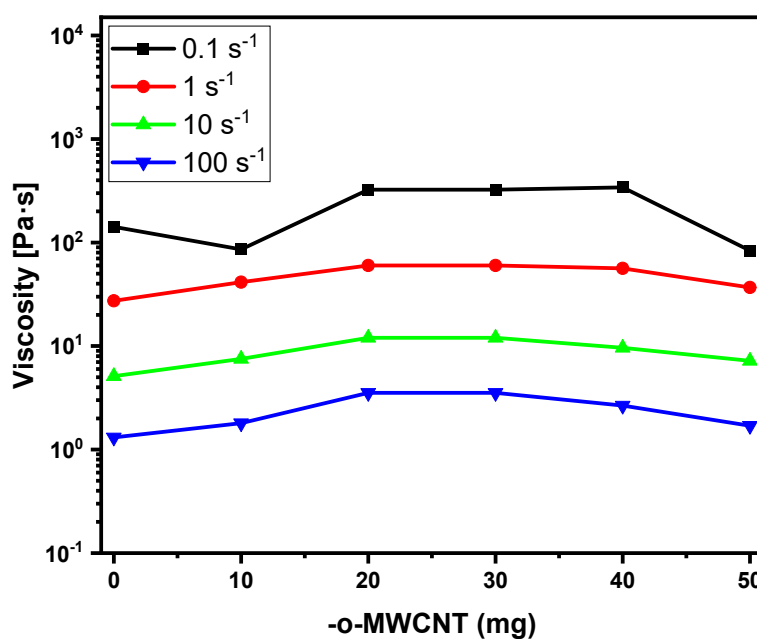


Figure S2. Viscosity versus *-o*-MWCNT concentration on shear rate.

Table S2. The values of storage modulus, loss modulus, complex viscosity and damping factor with angular frequency at 0.1, 1, 10 and 100 (rad/s)

| Hydrogels | Angular Frequency (rad/s) | | | | | | | | | | | | | | | |
|-------------|---------------------------|------|--------------|----------|------|------|--------------|----------|------|------|--------------|----------|------|------|--------------|----------|
| | 0.1 | | | | 1 | | | | 10 | | | | 100 | | | |
| | G' | G'' | tan δ | η^* | G' | G'' | tan δ | η^* | G' | G'' | tan δ | η^* | G' | G'' | tan δ | η^* |
| GGNIPACNT-0 | 35.8 | 6.19 | 0.173 | 364 | 41.7 | 6.27 | 0.15 | 42.2 | 51.3 | 11.1 | 0.217 | 5.25 | 62.4 | 24.2 | 0.387 | 0.669 |
| GGNIPACNT-1 | 151 | 19.5 | 0.129 | 1520 | 159 | 23.5 | 0.148 | 161 | 195 | 34.4 | 0.177 | 19.8 | 243 | 53.4 | 0.22 | 2.48 |
| GGNIPACNT-2 | 3110 | 1390 | 0.447 | 34000 | 309 | 37.6 | 0.122 | 311 | 355 | 50.4 | 0.142 | 35.9 | 514 | 85.6 | 0.167 | 5.21 |
| GGNIPACNT-3 | 27500 | 7210 | 0.262 | 284000 | 4830 | 1380 | 0.287 | 5030 | 4810 | 1360 | 0.282 | 499 | 5880 | 1690 | 0.287 | 61.2 |
| GGNIPACNT-4 | 159 | 23.5 | 0.148 | 1610 | 153 | 18 | 0.118 | 154 | 177 | 25.4 | 0.144 | 17.9 | 297 | 48.2 | 0.162 | 3.01 |
| GGNIPACNT-5 | 247 | 76.7 | 0.31 | 2590 | 138 | 21.1 | 0.152 | 140 | 161 | 26.6 | 0.166 | 16.3 | 226 | 33.6 | 0.149 | 2.28 |

Table S3 Storage and loss moduli values of GGNIPACNT-0 to GGNIPACNT-5 at the temperatures 40°C and 60 °C for heating.

| Hydrogels | Temperature 40 °C | | Temperature 60 °C | |
|-------------|-------------------|------|-------------------|------|
| | G' | G'' | G' | G'' |
| GGNIPACNT-0 | 174 | 31.3 | 294 | 92 |
| GGNIPACNT-1 | 121 | 34.4 | 129 | 34.8 |
| GGNIPACNT-2 | 77 | 16.1 | 83.7 | 18.5 |
| GGNIPACNT-3 | 87.4 | 16.3 | 191 | 52.1 |
| GGNIPACNT-4 | 204 | 34.8 | 237 | 37.9 |
| GGNIPACNT-5 | 146 | 25.1 | 172 | 28 |

Table S4 Storage and loss moduli values of GGNIPACNT-0 to GGNIPACNT-5 at the temperatures 40°C and 60 °C for cooling.

| Hydrogels | Temperature 40 °C | | Temperature 60 °C | |
|-------------|-------------------|-------|-------------------|-------|
| | G' | G'' | G' | G'' |
| GGNIPACNT-0 | 180 | 204 | 205 | 310 |
| GGNIPACNT-1 | 4740 | 1410 | 3170 | 960 |
| GGNIPACNT-2 | 61600 | 15300 | 45400 | 13700 |
| GGNIPACNT-3 | 50900 | 10900 | 66500 | 15400 |
| GGNIPACNT-4 | 12700 | 4380 | 11600 | 4260 |
| GGNIPACNT-5 | 25700 | 6570 | 29100 | 8000 |

Table S5. The value of elastic and viscous moduli and $\tan\delta$ at 1, 10, 25 and 99.8 % of strain of GGNIPACNT-0 to GGNIPACNT-5.

| Hydrogels | 1 % strain | | | 10 % strain | | | 25 % strain | | | 99.8 % strain | | |
|-------------|------------|------|--------------|-------------|------|--------------|-------------|------|--------------|---------------|------|--------------|
| | G' | G'' | $\tan\delta$ | G' | G'' | $\tan\delta$ | G' | G'' | $\tan\delta$ | G' | G'' | $\tan\delta$ |
| GGNIPACNT-0 | 62.1 | 14.1 | 0.227 | 45.5 | 15.4 | 0.339 | 34.2 | 17.4 | 0.511 | 14.6 | 16.5 | 1.12 |
| GGNIPACNT-1 | 181 | 32.8 | 0.181 | 155 | 41.1 | 0.265 | 112 | 53.4 | 0.478 | 31.5 | 42.6 | 1.35 |
| GGNIPACNT-2 | 190 | 25.7 | 0.135 | 158 | 36.5 | 0.231 | 120 | 48.6 | 0.404 | 44.4 | 49.6 | 1.12 |
| GGNIPACNT-3 | 288 | 42.7 | 0.149 | 236 | 62.9 | 0.267 | 166 | 85.1 | 0.512 | 46.8 | 64.3 | 1.38 |
| GGNIPACNT-4 | 205 | 34.6 | 0.169 | 169 | 45.7 | 0.271 | 116 | 59.3 | 0.512 | 30.7 | 41.7 | 1.36 |
| GGNIPACNT-5 | 175 | 22.4 | 0.129 | 151 | 29.7 | 0.197 | 112 | 46.2 | 0.411 | 34.9 | 46.7 | 1.34 |

Table S6 The value of shear stress (pa) at 0.1, 10, 25.1 and 99.8 % of strain of GGNIPACNT-0- GGNIPACNT-5.

| Hydrogels | 0.1 % | 1 % | 10 % | 25.1 % | 99.8 % |
|-------------|--------|-------|------|--------|--------|
| GGNIPACNT-0 | 0.0668 | 0.634 | 4.78 | 9.6 | 22 |
| GGNIPACNT-1 | 0.18 | 1.84 | 16 | 31 | 52.9 |
| GGNIPACNT-2 | 0.193 | 1.91 | 16.2 | 32.5 | 66.4 |
| GGNIPACNT-3 | 0.289 | 2.9 | 24.3 | 46.8 | 79.5 |
| GGNIPACNT-4 | 0.205 | 2.07 | 17.5 | 32.6 | 51.7 |
| GGNIPACNT-5 | 0.177 | 1.76 | 15.3 | 30.4 | 58.2 |