# Supplementary Information

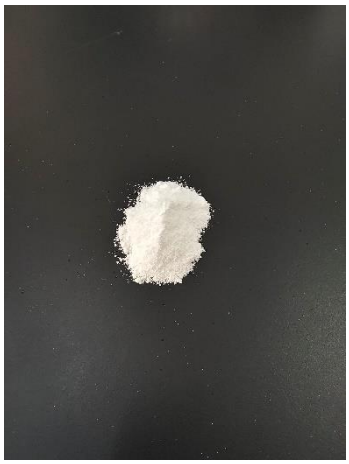

**Figure S1.** BDM powder.

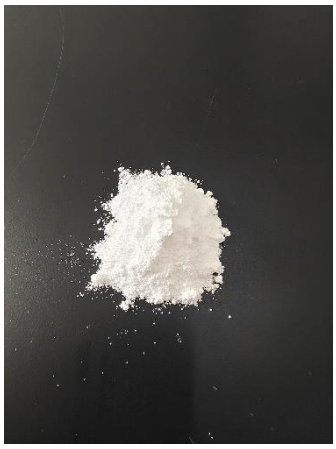

**Figure S2.** BDH powder.

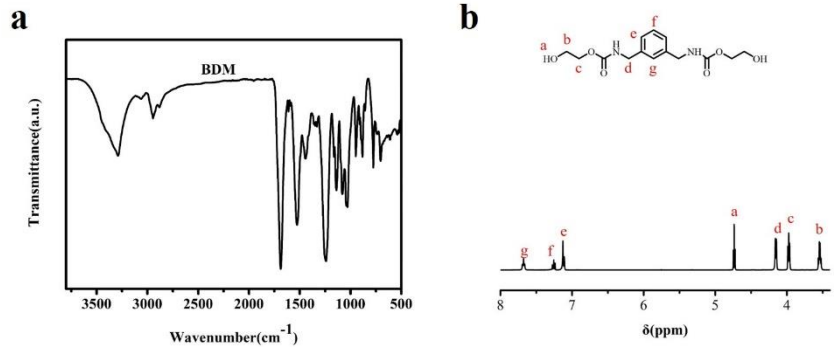


**Figure S3.** (a) FTIR spectra of BDH; (b) $^{1}$HNMR spectrum of BDH.

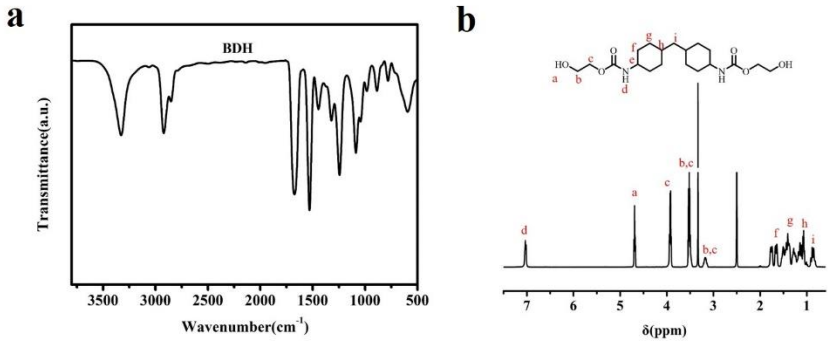


**Figure S4.** (a) FTIR spectra of BDH; (b) $^{1}$HNMR spectrum of BDH.

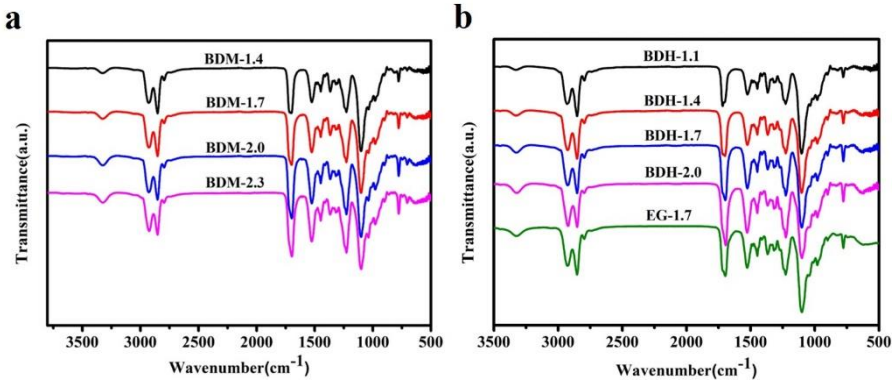


**Figure S5.** (a) FTIR spectra of BDM-based elastomers; (b) FTIR spectra of BDH-based and EG-1.7 elastomers.

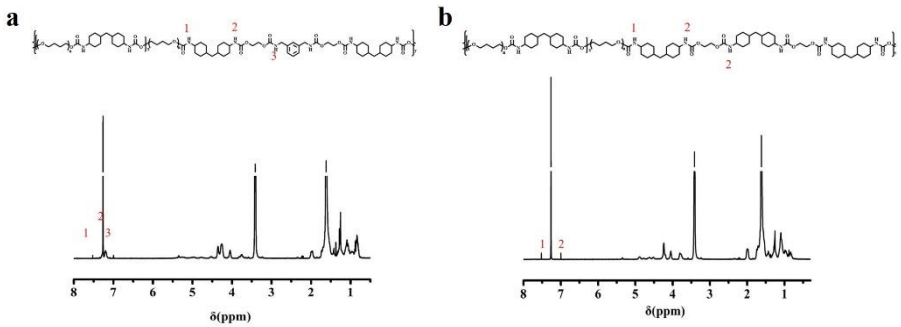


**Figure S6.** (a) $^{1}$HNMR spectrum of BDM-1.7 elastomer, chemical shift for peak 1, 2 and 3 is 7.51, 7.20 and 7.00 ppm, respectively; (b) $^{1}$HNMR spectrum of BDH-1.7 elastomer, chemical shift for peak 1 and 2 is 7.55, 7.01 ppm, respectively.

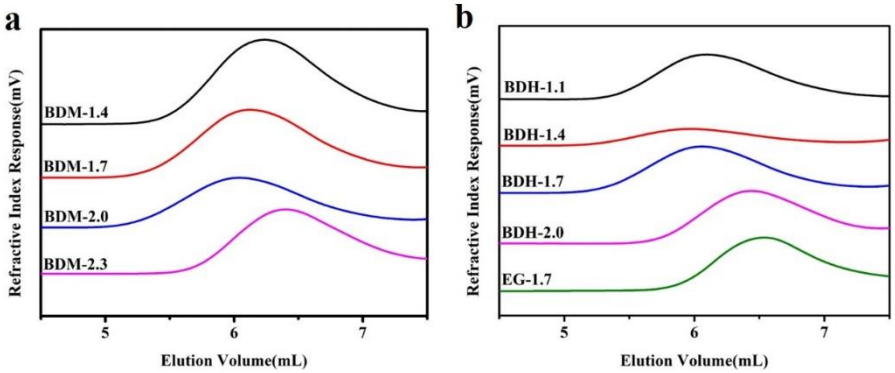


**Figure S7.** (a) GPC profiles for BDM-based elastomers; (b) GPC profiles for BDH-based and EG-1.7 elastomers.

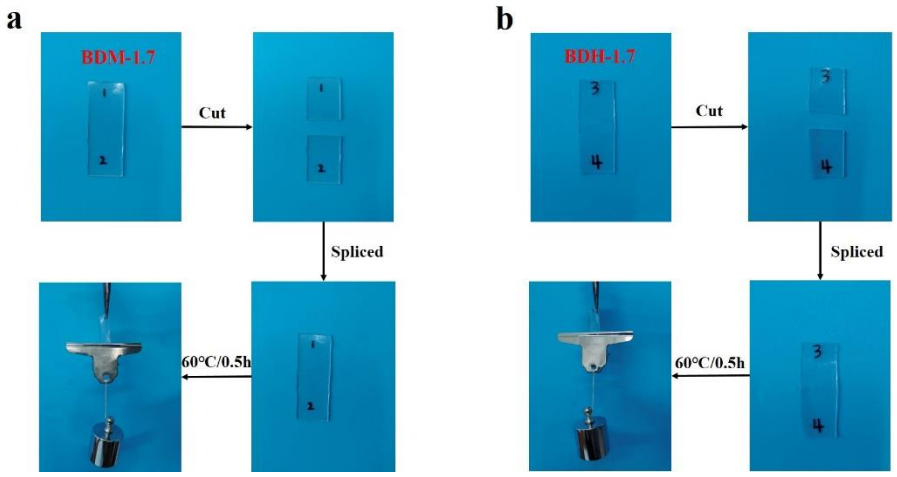


**Figure S8.** (a)and (b) The photos show that BDM-1.7 and BDH-1.7 elastomer tapes can be cut and processed at 60 °C for 0.5 h after splicing, which can increase the load of 500 g.

**Table S1.** Characteristic peak assignments of BDM.

| Assignments | Wavenumber ($cm^{-1}$) |
|---|---|
| ν (O-H) | 3450,3411 |
| ν (N-H) | 3289 |
| $\nu_{s\text{-}trans}$ (N-H) | 3063 |
| $\nu_{as}$ ($CH_2$) | 2928 |
| $\nu_{a}$ ($CH_2$) | 2852 |
| ν (C=O) | 1687 |
| m-benzene ring | 1603,1593,1493, 777,704 |
| δ (N-H) | 1525 |
| ν (C-O-C) | 1138 |
| ν (C-OH) | 1044 |

**Table S2.** Characteristic peak assignments of BDH.

| Assignments | Wavenumber ($cm^{-1}$) |
|---|---|
| ν (N-H) | 3324 |
| $\nu_{s\text{-}trans}$ (N-H) | 3060 |
| $\nu_{a}$ ($CH_2$) | 2921 |
| $\nu_{s}$ ($CH_2$) | 2855 |
| ν (C=O) | 1689 |
| δ (N-H) | 1528 |
| ν (C-O-C) | 1133 |
| ν (C-OH) | 1041 |

**Table S3.** Ingredients of BDM-based elastomers.

| Sample | R value | Molar feed ratio [a] | Hard segments (wt%) | |
|---|---|---|---|---|
| | | | Short | Long |
| BDM-1.4 | 1.4 | 1 : 1.4 : 0.4 | 10.5 | 22.5 |
| BDM-1.7 | 1.7 | 1 : 1.7 : 0.7 | 4.7 | 35.2 |
| BDM-2.0 | 2.0 | 1 : 2.0 : 1.0 | 0 | 45.6 |
| BDM-2.3 | 2.3 | 1 : 2.3 : 1.3 | 0 | 50.2 |

[a] PTMEG : HMDI : BDM.

**Table S4.** Ingredients of BDH-based elastomers.

| Sample | R value | Molar feed ratio [a] | Hard segments (wt%) | |
|---|---|---|---|---|
| | | | Short | Long |
| BDH-1.1 | 1.1 | 1 : 1.1 : 0.1 | 10.9 | 13.8 |
| BDH-1.4 | 1.4 | 1 : 1.4 : 0.4 | 10.4 | 23.9 |
| BDH-1.7 | 1.7 | 1 : 1.7 : 0.7 | 4.6 | 37.2 |
| BDH-2.0 | 2.0 | 1 : 2.0 : 1.0 | 0 | 53.7 |
| EG-1.7 | 1.7 | 1 : 1.7 : 0.7 | 5.3 | 27.6 |

[a] PTMEG : HMDI : BDH.

**Table S5.** Characteristic peak assignments of BDM-based elastomers.

| Assignments | Wavenumber ($cm^{-1}$) |
|---|---|
| free ν (N-H) | 3454 |
| H-bonded ν (N-H) | 3323 |
| $\nu_a$ ($CH_2$) | 2928 |
| $\nu_s$($CH_2$) | 2852 |
| $\nu_s$($CH_2$) | 2796 |
| Free ν(C=O) amide I of urethane | 1717 |
| H-bonded ν(C=O) amide I of urethane | 1697 |
| m-benzene ring | 1609, 777,704 |
| δ (N-H) | 1525 |
| ν (C-O-C) | 1100 |

**Table S6.** Characteristic peak assignments of BDH-based elastomers.

| Assignments | Wavenumber ($cm^{-1}$) |
|---|---|
| free ν(N-H) | 3450 |
| H-bonded ν(N-H) | 3321 |
| $\nu_a$ ($CH_2$) | 2921 |
| $\nu_s$ ($CH_2$) | 2851 |
| $\nu_s$ ($CH_2$) | 2796 |
| free ν (C=O) amide I of urethane | 1721 |
| H-bonded ν (C=O) amide I of urethane | 1693 |
| δ (N-H) | 1526 |
| ν (C-O-C) | 1103 |

**Table S7.** Information of molecular weight of BDM-based elastomers.

| Sample | $M_n$(g/mol) | $M_w$(g/mol) | PDI [a] |
|---|---|---|---|
| BDM-1.4 | $1.312 \times 10^5$ | $2.722 \times 10^5$ | 2.08 |
| BDM-1.7 | $1.599 \times 10^5$ | $3.557 \times 10^5$ | 2.23 |
| BDM-2.0 | $1.883 \times 10^5$ | $4.436 \times 10^5$ | 2.36 |
| BDM-2.3 | $9.524 \times 10^4$ | $1.822 \times 10^5$ | 1.91 |

[a] polydispersity index.

**Table S8.** Information of molecular weight of BDH-based and EG-1.7 elastomers.

| Sample | $M_n$(g/mol) | $M_w$(g/mol) | PDI [a] |
|---|---|---|---|
| BDH-1.1 | $1.585 \times 10^5$ | $3.465 \times 10^5$ | 2.19 |
| BDH-1.4 | $2.446 \times 10^5$ | $4.913 \times 10^5$ | 2.00 |
| BDH-1.7 | $1.940 \times 10^5$ | $4.086 \times 10^5$ | 2.10 |
| BDH-2.0 | $9.635 \times 10^4$ | $1.697 \times 10^5$ | 1.76 |
| EG-1.7 | $6.996 \times 10^4$ | $1.409 \times 10^5$ | 2.01 |

[a] polydispersity index.

**Table S9.** Mechanical properties of BDM-based elastomers obtained from tensile tests.

| Sample | Tensile strength (MPa) | Elongation at break (%) | Toughness (MJ/m$^3$) |
|---|---|---|---|
| BDM-1.4 | 0.61 ± 0.03 | 805 ± 52 | 3.73 ± 0.19 |
| BDM-1.7 | 20.6 ± 1.3 | 1667 ±56 | 83.5 ± 2.0 |
| BDM-2.0 | 36.3 ± 1.3 | 1230 ± 61 | 122.3 ± 4.0 |
| BDM-2.3 | 43.9 ± 2.4 | 1144 ± 40 | 135.8 ± 6.8 |

**Table S10.** Mechanical properties of BDH-based and EG-1.7 elastomers obtained from tensile tests.

| Sample | Tensile strength (MPa) | Elongation at break (%) | Toughness (MJ/m$^3$) |
|---|---|---|---|
| BDH-1.1 | 0.19 ± 0.01 | 608± 93 | 0.58 ± 0.29 |
| BDH-1.4 | 12.9 ± 0.7 | 1740 ± 25 | 57.7 ± 1.1 |
| BDH-1.7 | 37.1 ± 1.7 | 1128 ± 53 | 118.8 ± 5.1 |
| BDH-2.0 | 44.0 ± 3.3 | 1079 ± 20 | 197.9 ± 7.9 |
| EG-1.7 | 0.13 ± 0.02 | 491 ± 30 | 0.43 ± 0.1 |

**Table S11.** The Self-healing efficiencies of BDM-1.7 elastomers.

| | Sample | 25 °C/24h | 40 °C/12h | 60 °C/24h |
|---|---|---|---|---|
| Tensile strength S.E. (%) | BDM-1.7 | 24.7 | 60.4 | 99.8 |
| Elongation at break S.E. (%) | BDM-1.7 | 64.9 | 90.0 | 100.0 |
| Toughness S.E. (%) | BDM-1.7 | 30.2 | 67.7 | 98.8 |

**Table S12.** The Self-healing efficiencies of BDH-1.7 elastomers.

| | Sample | 25 °C/24h | 40 °C/12h | 60 °C/24h | 60 °C/4h | 60 °C/8h | 60 °C/12h |
|---|---|---|---|---|---|---|---|
| Tensile strength S.E. (%) | BDH-1.7 | 19.2 | 64.0 | 95.2 | 50.7 | 61.6 | 77.0 |
| Elongation at break S.E. (%) | BDH-1.7 | 52.2 | 87.1 | 99.4 | 81.5 | 87.3 | 93.2 |
| Toughness S.E. (%) | BDH-1.7 | 16.7 | 67.8 | 95.6 | 51.6 | 59.4 | 79.7 |