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Electronic Supplementary information

Voltage-stabilised elastomers with increased relative permittivity and high electrical breakdown strength by means of phase separating binary copolymer blends of silicone elastomers

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1) Calculation of engineering stress and strain

The engineering stress ($\sigma_E$) was calculated from the force ($F$) and the cross-sectional area of the strip ($A$):

$$\sigma_E = \frac{F}{A} = \frac{F}{t \times w} = \frac{\tau \cdot d}{t \cdot w}$$

Equation 1

where $A = \text{film thickness} \cdot \text{constant width} (w = 6 \text{ mm})$ and $F = \text{torque} \cdot \text{drum diameter} (d = 10.3 \text{ mm})$.

The engineering strain ($\varepsilon_E$) was calculated as a ratio of a stretched strain ($L - L_0$) to an initial strain ($L_0$) as:

$$\varepsilon_E = \frac{L - L_0}{L_0}$$

Equation 2

where a final strain after stretching ($L$) was determined from Hencky strain ($\varepsilon_H$) as follows:

$$\varepsilon_H = \ln \frac{L}{L_0}$$

Equation 3

$$L = L_0 e^{\varepsilon_H} = L_0 e^{(r_H t_s)}$$

Equation 4

where $\varepsilon_H$ is a product of Hencky rate ($r_H = 1 \times 10^{-3} \text{ rotation/s}$) and step time ($t_s$).

By putting equation (4) in (2), the final expression of engineering strain ($\varepsilon_E$) was obtained as below:

$$\varepsilon_E = e^{\varepsilon_H} - 1$$

Equation 5

Young’s moduli were determined from slopes in the linear regime of stress-strain plots at 5 % strain.
2) NMR spectra of synthesised copolymers

The NMR spectra for synthesised PDMS-PPMS and PDMS-PEG copolymers are shown in Figures S1–S5.

a) PDMS-PPMS copolymer (80DMS_2PMS, $C_{C_6H_{16}} = 8.4 \cdot 10^{-4}$ mol g$^{-1}$)

$^1$H-NMR (CDCl$_3$, 300 MHz): $\delta$ -0.02 - $\delta$ 0.6 (m, 6 H’s, -SiO(C$_3$H$_3$)$_2$-), $\delta$ 4.70 (m, 1 H, -SiH-), $\delta$ 7.10 - $\delta$ 7.60 (m, 5 H’s, -SiC$_6$H$_5$-).

Figure S1 The NMR for 80DMS_2PMS.

b) PDMS-PEG copolymer (PDMS81-PEG)

$^1$H-NMR (CDCl$_3$, 300 MHz): $\delta$ 0.05 - $\delta$ 0.09 (m, 6 H’s, -Si(CH$_3$)$_2$O-), $\delta$ 3.50 - $\delta$ 3.70 (m, 4 H’s, -C$_2$H$_4$O-), $\delta$ 0.98 - $\delta$ 1.03 (t, 2 H’s, -SiCH$_2$-), $\delta$ 3.53 - $\delta$ 3.57 (m, 2 H’s, -CCH$_2$O-).

Figure S2 The NMR for PDMS81-PEG.
c) PDMS-PEG copolymer (PDMS14-PEG)

$^1$H-NMR (CDCl$_3$, 300 MHz): $\delta$ 0.05 - $\delta$ 0.09 (m, 6 H’s, -Si(CH$_3$)$_2$O-), $\delta$ 3.50 - $\delta$ 3.70 (m, 4 H’s, -C$_2$H$_4$O-), $\delta$ 0.98 - $\delta$ 1.03 (t, 2 H’s, -SiCH$_2$-), $\delta$ 3.53 - $\delta$ 3.57 (m, 2 H’s, -CCH$_2$O-).

Figure S3 The NMR for PDMS14-PEG.

d) PDMS-PEG copolymer (PDMS7-PEG)

$^1$H-NMR (CDCl$_3$, 300 MHz): $\delta$ 0.05 - $\delta$ 0.09 (m, 6 H’s, -Si(CH$_3$)$_2$O-), $\delta$ 3.50 - $\delta$ 3.70 (m, 4 H’s, -C$_2$H$_4$O-), $\delta$ 0.98 - $\delta$ 1.03 (t, 2 H’s, -SiCH$_2$-), $\delta$ 3.53 - $\delta$ 3.57 (m, 2 H’s, -CCH$_2$O-).

Figure S4 The NMR for PDMS7-PEG.
e) PDMS-PEG copolymer (PDMS3-PEG)

$^1$H-NMR (CDCl$_3$, 300 MHz): $\delta$ 0.05 - $\delta$ 0.09 (m, 6 H’s, -Si(CH$_3$)$_2$O-), $\delta$ 3.50 - $\delta$ 3.70 (m, 4 H’s, -C$_2$H$_4$O-), $\delta$ 0.98 - $\delta$ 1.03 (t, 2 H’s, -SiCH$_2$-), $\delta$ 3.53 - $\delta$ 3.57 (m, 2 H’s, -CCH$_2$O-).

![NMR spectrum](image)

Figure S5 The NMR for PDMS3-PEG.

3) SEM images

![SEM images](image)
Figure S6 SEM images cross-linked BCBs with: a) 10 phr PDMS81-PEG, b) 20 phr PDMS81-PEG, c) 10 phr PDMS14-PEG, d) 20 phr PDMS14-PEG, e) 10 phr PDMS7-PEG, f) 10 phr PDMS3-PEG, and g) 20 phr PDMS3-PEG.