Supplementary information

Rehabilitation Physical, Mechanical, Antibacterial and Cell growth Properties of Bio-Rubber Polymers Based on Poly(Glycerol Sebacic acid) with Helping Curcumin and Hydroxyapatite Nanoparticles

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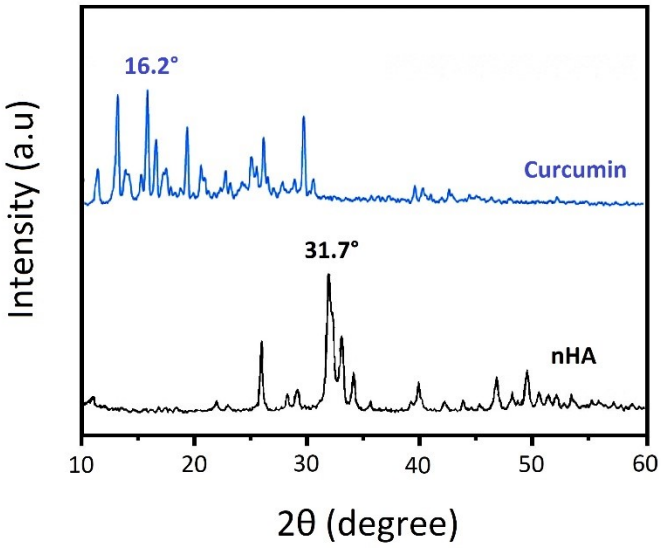

Figure S1. X-ray diffraction of curcumin powder and hydroxyapatite nanoparticles.

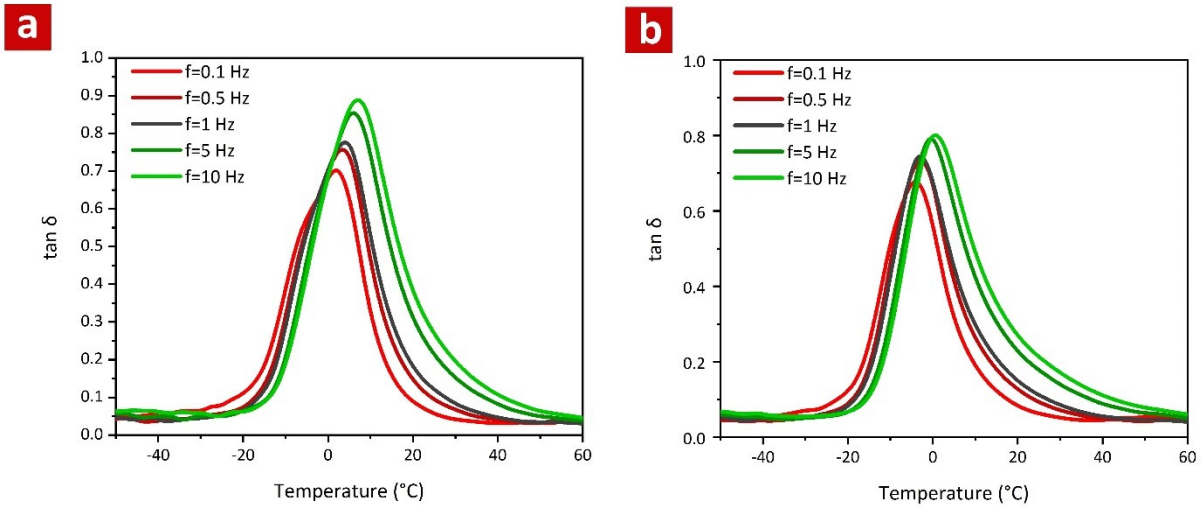

Figure S2. Effect of multi frequencies on loss factor (Tan δ) of investigated PGSU-based elastomers: **(a)** PGSU-HA and **(b)** PGSU-Cu

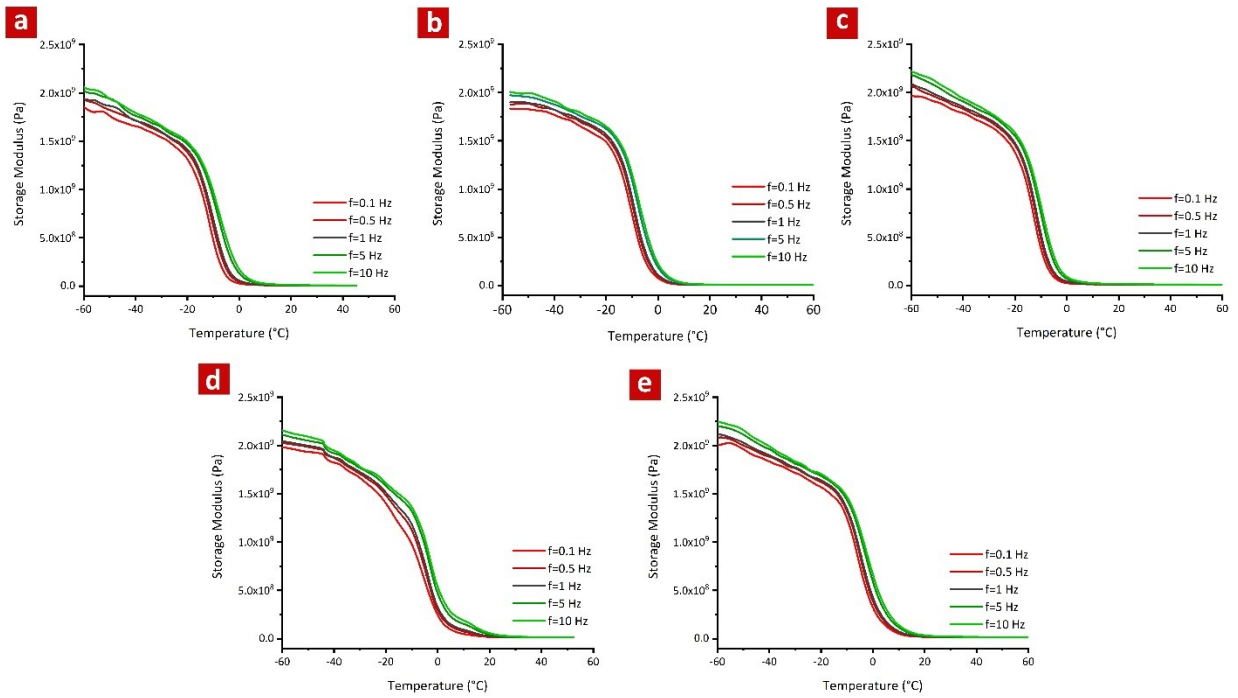

Figure S3. Effect of multi frequencies on storage modulus (E') of investigated PGSU-based elastomers: **(a)** PGSU, **(b)** PGSU-HA, **(C)** PGSU-Cu, **(d)** PGSU-HA-Cu5 and **(e)** PGSU-HA-Cu3

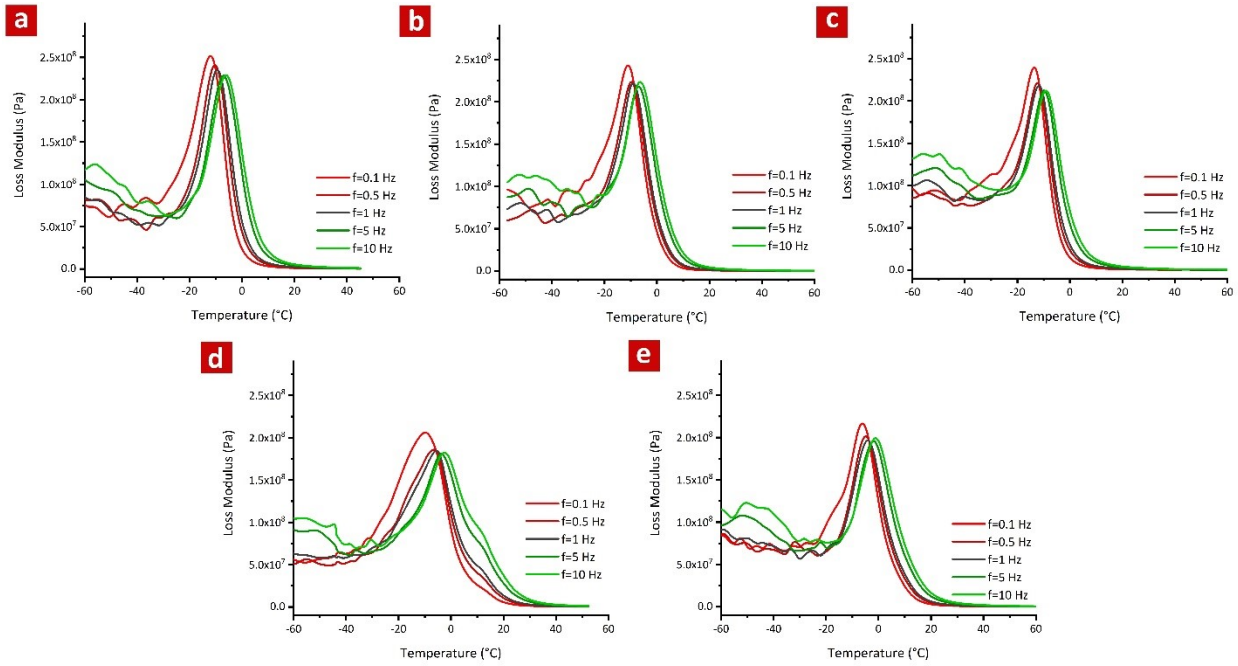

Figure S4. Effect of multi frequencies on loss modulus (E") of investigated PGSU-based elastomers: **(a)** PGSU, **(b)** PGSU-HA, **(C)** PGSU-Cu, **(d)** PGSU-HA-Cu5 and **(e)** PGSU-HA-Cu3

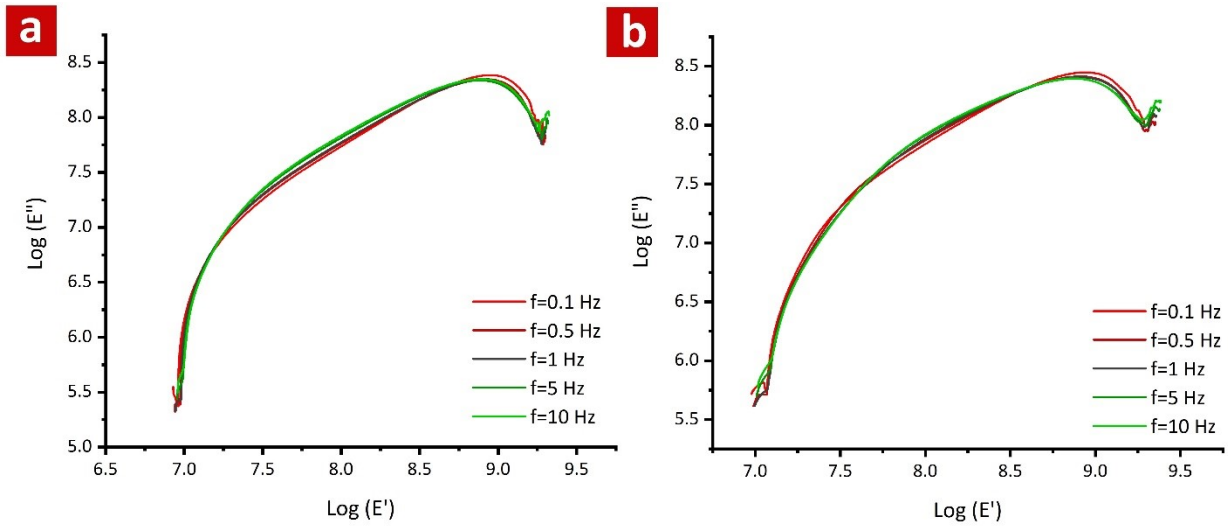

Figure S5. Cole-Cole plots at various frequencies: **(a)** PGSU-HA and **(b)** PGSU-Cu.

1. Generating Master curves

For storage modulus, TTS principle can be expressed by the equation S1:

$$E'(f\,a_T, T_r) = E'(f, T) \qquad \text{(S1)}$$

Where a_T, f and T_r are the horizontal shift factor, frequency and the reference temperature, respectively. In the temperature range of Tg to Tg+100 °C, the shift factor (a_T) can be calculated by the Williams-Landel-Ferry (WLF) equation expressed as:[1]

$$Log(a_t) = \frac{-C_1(T - T_0)}{C_2 + (T - T_0)} \qquad \text{(S2)}$$

Where T_0 is the reference temperature and C_1 and C_2 are WLF constants. If T_g is taken as T_0, the C_1 and C_2 are equal to 17.4 and 51.6, respectively. For other reference temperatures the WLF constants (C_1^0 and C_2^0) can be calculated by the following equations:[1]

$$C_1^0 = \frac{C_1^g C_2^g}{C_1^g + T_0 - T_g} \qquad \text{(S3)}$$

$$C_2^0 = C_2^g + T_0 - T_g \qquad \text{(S4)}$$

Where C_1^g and C_2^g are WLF constant at T_g.

Table S1. WLF constants and calculated log(a_T) for all samples at a reference temperature of 37°C.

Sample	T_g (°C)	WLF Constant (C_1)	WLF Constant (C_2)	Log(a_T)									
				0(°C)	5(°C)	10(°C)	15(°C)	20(°C)	25(°C)	30(°C)	35(°C)	45(°C)	55(°C)
PGSU	-9.5	14.0742	98.1	8.523	6.814	5.345	4.069	2.950	1.962	1.081	0.293	-1.061	-2.182
PGSU-HA	-9	14.1851	97.6	8.661	6.920	5.425	4.128	2.992	1.989	1.096	0.297	-1.075	-2.209
PGSU-Cu	-11.5	13.6473	100.1	8.002	6.413	5.041	3.844	2.792	1.859	1.026	0.278	-1.010	-2.080
PGSU-HA-Cu5	-5.5	15.0134	94.1	9.728	7.736	6.041	4.581	3.310	2.194	1.207	0.326	-1.176	-2.411
PGSU-HA-Cu3	-4	15.3988	92.6	10.247	8.131	6.338	4.798	3.463	2.293	1.259	0.340	-1.225	-2.506

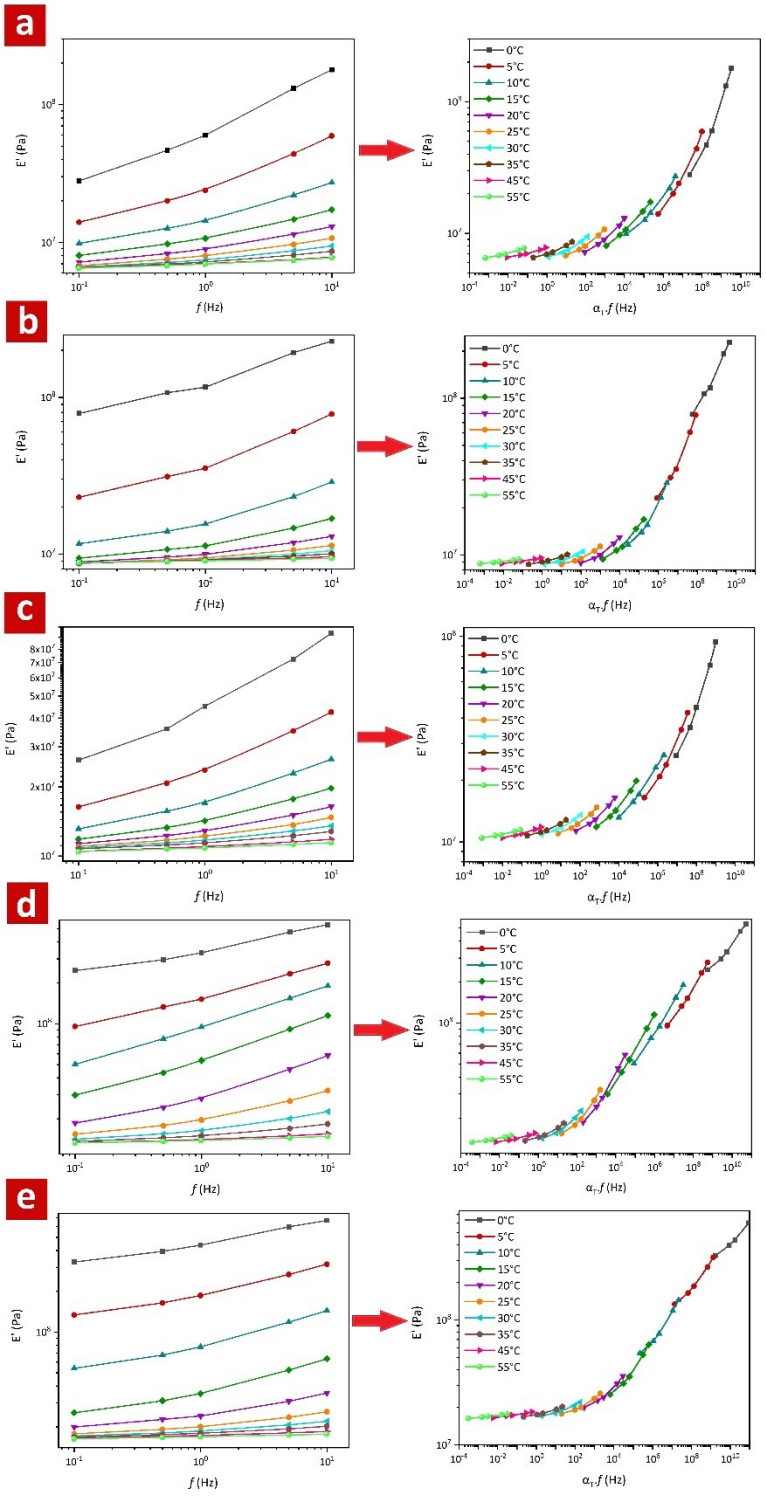

Figure S6. Frequency sweep data versus storage modulus and transferred plot of storage modulus of (a) PGSU, (b) PGSU-HA, (c) PGSU-Cu, (d) PGSU-HA-Cu5, and (e) PGSU-HA-Cu3 at a reference temperature of 37°C.

2. Calculating surface tension

Wetting phenomena on a macroscopic scale can be shown by Young's equation.[2]

$$\gamma_{lv}\cos\theta = \gamma_{sv} - \gamma_{sl} \quad \text{(S5)}$$

Where θ is the contact angle, γ_{sl} is solid-liquid interfacial free energy, γ_{lv} is liquid surface tension and γ_{sv} is solid surface free energy.

The solid surface free energy of an unknown material can be calculated through Owens-Wendt method:[2,3]

$$\gamma_{sl} = \gamma_{sv} + \gamma_{lv} - 2\left(\sqrt{\gamma_{sv}^{D}\gamma_{lv}^{D}} + \sqrt{\gamma_{sv}^{P}\gamma_{lv}^{P}}\right) \quad \text{(S6)}$$

Where γ_{sv}^{D} and γ_{lv}^{D} are dispersive portions and γ_{sv}^{P} and γ γ_{lv}^{P} are polar portions of solid and liquid surface energies, respectively. By combining Eq.S5 and Eq.S6:

$$\sqrt{\gamma_{sv}^{D}\gamma_{lv}^{D}} + \sqrt{\gamma_{sv}^{P}\gamma_{lv}^{P}} = 0.5[\gamma_{lv}(1+\cos\theta)] \quad \text{(S7)}$$

The solid surface free energy of an unknown material can also be calculated through Wu- harmonic-mean equation:[3]

$$\gamma_{sl} = \gamma_{sv} + \gamma_{lv} - 4\left(\frac{\gamma_{sv}^{d}\gamma_{lv}^{d}}{\gamma_{sv}^{d}+\gamma_{lv}^{d}} + \frac{\gamma_{sv}^{p}\gamma_{lv}^{p}}{\gamma_{sv}^{p}+\gamma_{lv}^{p}}\right) \quad \text{(S8)}$$

By combining Eq.S8 and Eq.S5:

$$\frac{\gamma_{sv}^{d}\gamma_{lv}^{d}}{\gamma_{sv}^{d}+\gamma_{lv}^{d}} + \frac{\gamma_{sv}^{p}\gamma_{lv}^{p}}{\gamma_{sv}^{p}+\gamma_{lv}^{p}} = 0.25[\gamma_{lv}(1+\cos\theta)] \quad \text{(S9)}$$

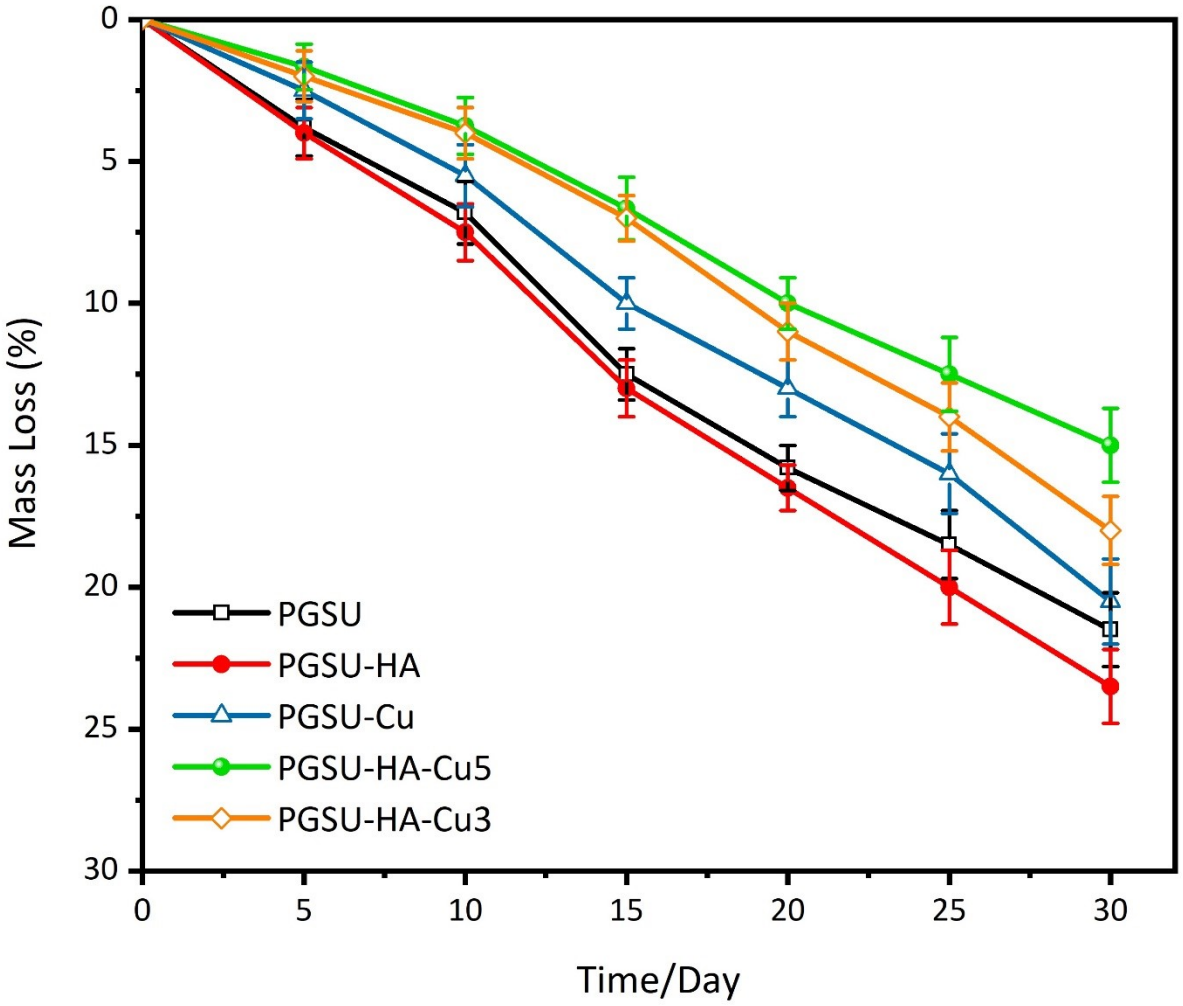

Figure S7. *In-vitro* enzymatic degradations profile of the bioelastomers in PBS solution (pH=7.4) at 37 °C

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