A simple model relating gauge factor to filler loading in nanocomposite strain sensors

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Piezoresistive polymer nanocomposites are typically filled with conductive nanomaterials such as graphene [1], carbon nanotubes [2] and other 2D materials [3]. These nanocomposites often display significant changes in resistance when deformed, and display sensitivities, or gauge factors, far beyond what is achievable with traditional metal foil strain gauges. This, coupled with a soft and flexible polymer matrix makes them ideal candidates as strain sensors in areas such as human health monitoring and robotics. However a challenge still remains in understanding the physical mechanisms underlying nanocomposite sensors and hence optimizing their performance. We have developed a simple model which yields equations for nanocomposite gauge factors as a function of both filler volume fraction and composite conductivity. These equations can be used to fit experimental data, outputting figures of merit, or predict experimental data once certain physical parameters are known. We have found these equations to match data, measured from our own experimental work and extracted from the literature, extremely well. Importantly, the model shows the response of composite strain sensors to be more complex than previously thought and shows factors other than the effect of strain on the interparticle resistance to be performance limiting [4].

REFERENCES

[1] Boland et al., Science 2016, 354, 6317, 1257-1260
[2] Hu et al., Carbon 2010, 48, 680 – 687
[3] Biccai et al., *ACS Nano* 2019, *13* (6), 6845– 6855
[4] J R Garcia et al., ACS Appl. Nano Mater. 2021, 4, 3, 2876–2886

FIGURES

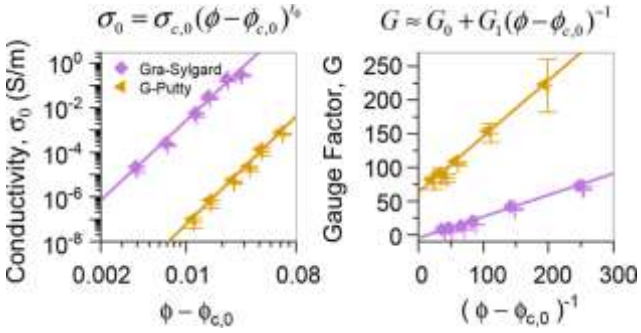

Figure 1: Percolation data and fits to graphene based polymer nanocomposites (Left). Gauge factor / Conductive filler data and model (Right).