Inkjet printed graphene on elastomers strain sensors

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Piezoresistive sensors are amongst the most widely used strain sensors[1, 2]. State-of-the-art metallic piezoresistive strain sensors have low gauge factors (GF: 2-5), defined as the ratio of relative change in electrical resistance to that in strain. PolySi and single crystal Si strain sensors work for strains up to ~5%[5], while requiring micro-fabrication[3]. Graphene based strain sensors have high GF>100[4]. Graphene is piezoresistive i.e., any external perturbation such as strain/force/pressure or deformation causes it to change its resistance[5]. Strain sensors have been prepared using CVD graphene [6], liquid phase exfoliated graphite[7] and reduced graphene oxide[8]. Printing (e.g. Inkjet & Screen) was reported on flexible but non-stretchable substrates[9], limiting their use for applications where strain sensing in tension or compression is required. Composites of graphene nanoplatelets with elastomeric polymers (e.g. Polydimethylsiloxane (PDMS)) were prepared by mixing[7] and infiltration[10], allowing both flexibility and stretch-ability. However, such composite-based sensors have non-monotonic change in resistance even without external stimuli, due to viscoelasticity[7,11]. In addition it is difficult to integrate such sensors to electronic components as they are not printable and have to be bonded manually. Here, we report inkjet printing of liquid phase exfoliated graphite in IPA on PDMS. Inks are produced by microfluidization of graphite[12], followed by centrifugation. Different patterns are selected so that the contact points between two conductive tracks are minimum and a significant change in resistance (>100%) is caused by a small mechanical strain (<3%), Fig. 1. We get GF~50-600 for a strain of up to 3%, Fig 2. This is~5 times higher than graphene based inkjet printed sensors on non-stretchable substrates[13]. This paves the way for scalable, flexible and stretchable piezoresistive sensors.

References

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Figures

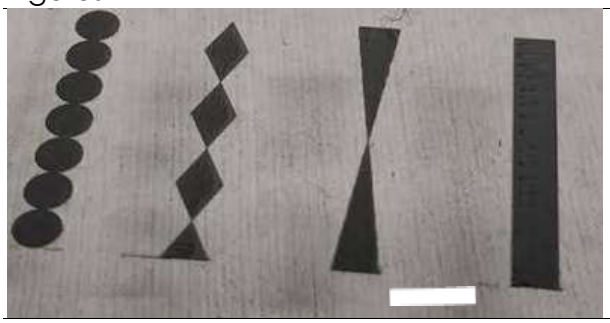

Figure 1: Inkjet-printed graphene strain gauges on PDMS (white scale-bar: 5mm)

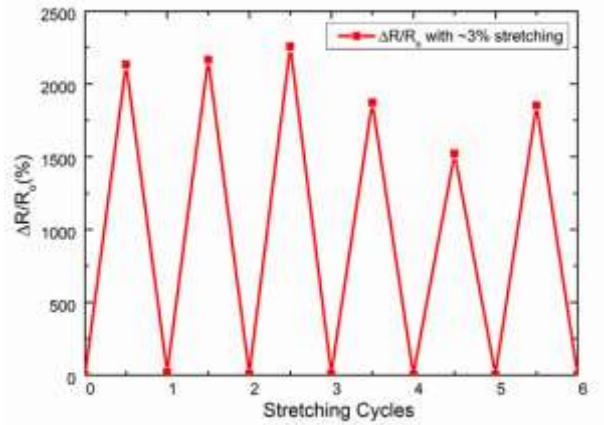

Figure 2: Change in resistance under ~3% stretching.