Piezoresistive sensing performance of ex-situ transferred nanocrystalline graphite on a flexible substrate

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Piezoresistive-based strain sensors can be used in a multitude of applications, from tracking industrial structural integrity, to health monitoring and man-machine interactions. Commercial-grade strain foil gauges usually employ – as a sensing element - either a patterned metallic film or a semiconductor bar; their gauge factor (GF) could be either ~2, or ~100, respectively. From this perspective, the carbonic materials, with a graphene-like structure, have proven to be a feasible alternative, exhibiting GFs with one order of magnitude higher [1]. In particular, the large area scalability of nanocrystalline graphene/graphite (NCG) [2] and its intrinsic and inter-molecular structure (Figure 1a) makes this type of material one of the top candidates for high-sensitivity (GF ~ 300, 600), low-strain (<1%), piezoresistive sensing [3, 4]. Our contribution presents the performance of NCG as a piezoresistive element in strain sensors. The NCG film is grown by plasma enhanced chemical vapour deposition (PECVD) on a metallic substrate; the structure and the morphology of the film is investigated by Raman spectroscopy and scanning electron microscopy (SEM). After the ex-situ transfer on a flexible substrate, the piezoresistive performance is investigated by measuring the electrical resistance of the sensitive layer during controlled mechanical stretching of the device (Figure 1b). Experimental results confirm NCG is a fitting material for low-strain piezoresitive sensing, GFs of up to 236 being recorded.

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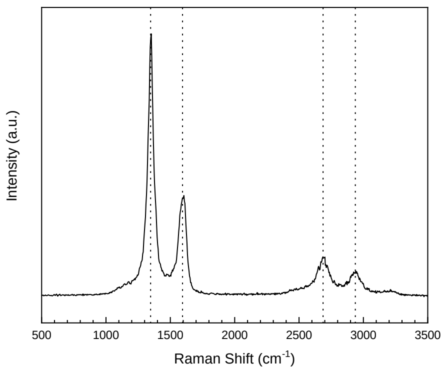
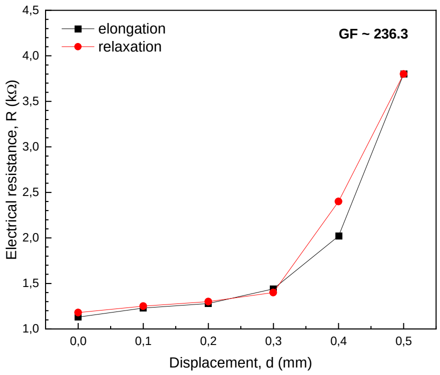
FIGURES



(a)



(b)

Figure 1: (a) Raman spectrum of a NCG film grown on a metallic substrate. The dotted lines at ~1347 cm^{-1}, 1595 cm^{-1}, 2687 cm^{-1}, 2937 cm^{-1} represent the specific D, G, 2D and D+D' peaks, respectively. (b) Electrical resistance variation with respect to the mechanical displacement for a 1.25 μm thick NCG film.

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