Graphene-Epoxy Flexible Capacitors Enhanced by Ceramic Fillers

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Organic flexible devices, such as capacitors, show great scientific and commercial interest, especially for applications in flexible/printed electronics [1–8]. Polymeric capacitors are particularly interesting and their attractive features include good processability, miniaturized dimensions, simplicity in device structure, good scalability, and low-cost potential [9–11]. In particular, polymeric composites containing high dielectric constant inorganic particles have been considered an ideal material for embedded capacitors, and ceramic powders, with high dielectric permittivity, can enhance the dielectric properties of the capacitors [12-16]. Graphene shows excellent mechanical resistance and electrical conductivity [17, 18], particularly when synthesized by means of Chemical Vapor Deposition (CVD) procedures, and it is very promising for applications in flexible electronics and devices [19].

In this contribution we will report an easy and elegant way to obtain a well adherent, transparent, and flexible graphene–epoxy interface through UV-induced bonding [20]. Figure 1 shows the detail of the fabrication process. Graphene–SU8 membrane presents two distinct surfaces: one is electrically conductive, containing the graphene membrane, while the other is a dielectric surface, typical of the epoxy resin. We bonded together two graphene–SU8 layers using an epoxy photocurable formulation, adding ceramic fillers in order to enhance the capacitive behavior of the devices. Figure 2 shows a summary of the electrical characterization results of the capacitors, comparing Gibbsite, Bohemite and Zirconia as filler enhancers, revealing stable and clear capacitive behavior [21].

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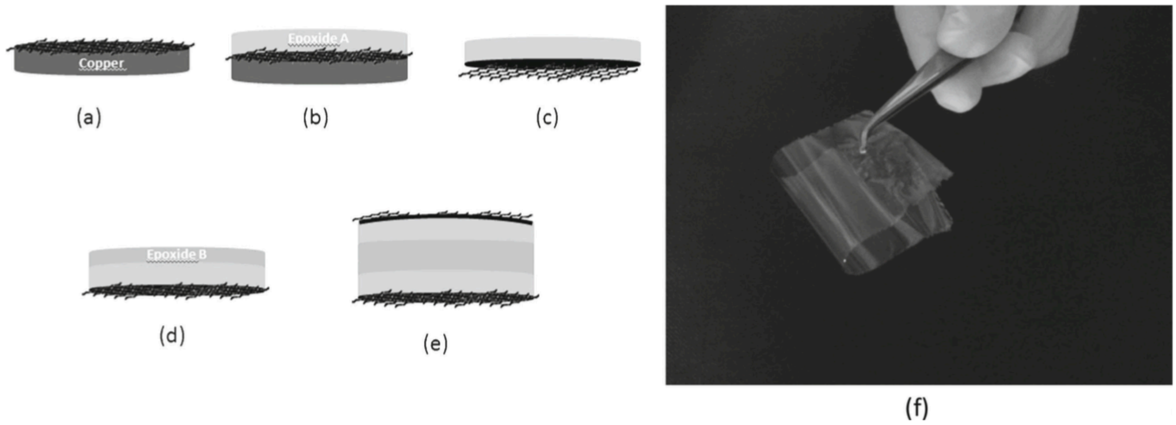

Figure 1: Production process. a) deposition of graphene by CVD on Cu; b) Spin-coating of SU8 on the top of the graphene layer; c) Wet etching of Cu substrate; d) Wire wound application of epoxy on the SU8 layer (performed on two samples); e) Coupling of the epoxy layers and UV curing to form the final device; f) Picture of the obtained device.

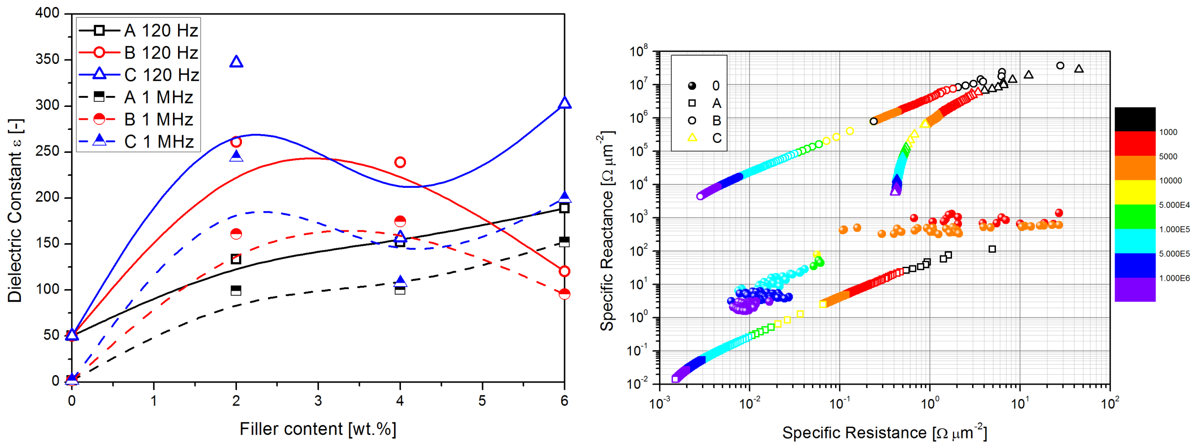

Figure 2: Dielectric constant versus nanoparticles content (Squares, gibbsite; circles, Bohemite and triangles, Zirconia). Nyquist plot for samples having epoxy interlayer with 6 wt% nanoparticles content (Squares, gibbsite; empty circles, Bohemite; triangles, Zirconia and filled circles unfilled epoxy layer).