SUPPORTING INFORMATION

1. Influence of the deformation of the yarn on the calculated conductivity

To determine the influence of the decrease of the cotton yarn diameter onto the electrical conductivity the diameter was measured for strains of $0\ \%, 4\ \%, 8\ \%$ and $12\ \%$ on SEM images (Fig. S1) and we obtained $1.1\ mm$, $0.95\ mm$, $0.92\ mm$ and $0.89\ mm$, respectively (Fig. S2).

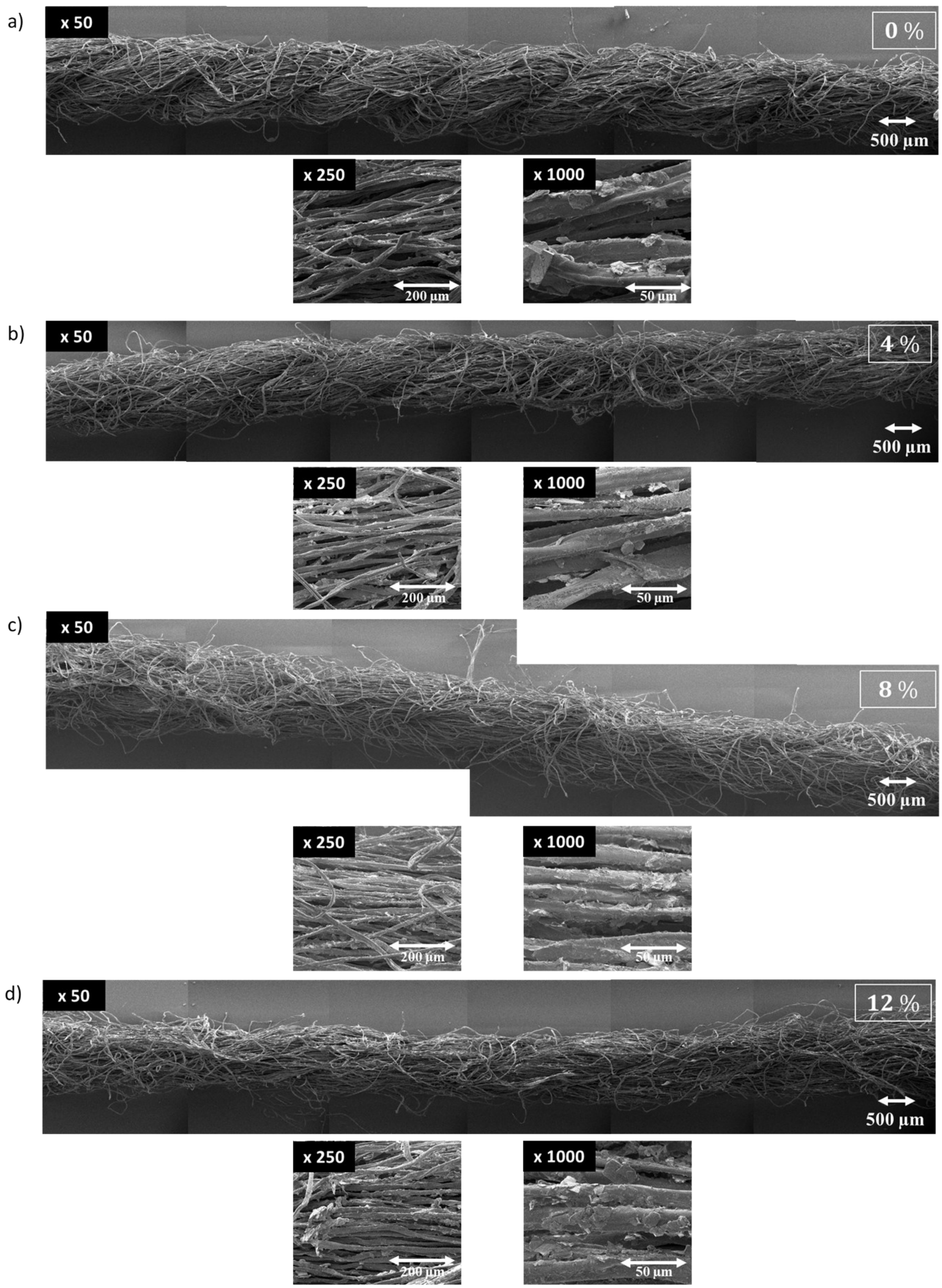

Figure S1: SEM images of G coated cotton yarn stretched at a) 0 %, b) 4 %, c) 8 % and d) 12 % and then released.

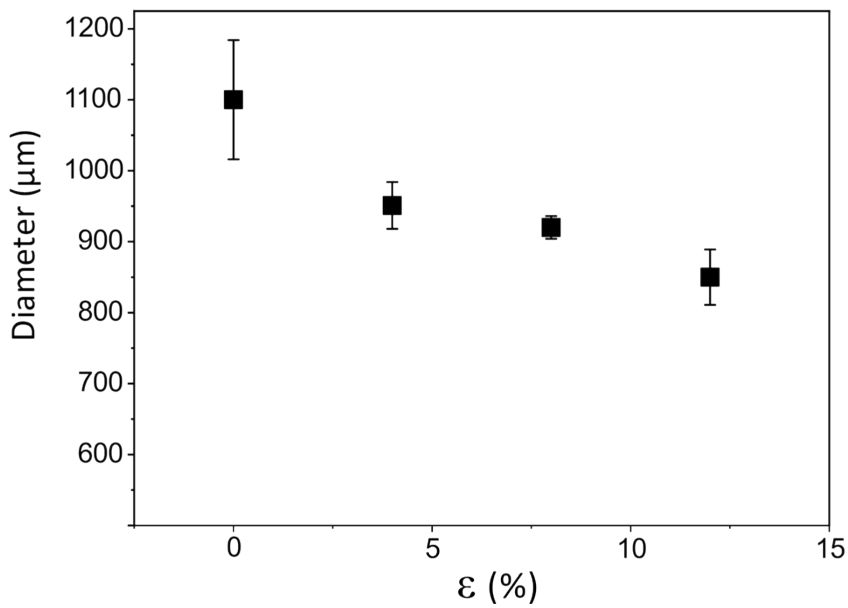

Figure S2: Evolution of the diameter of G-coated cotton yarn stretched at $0\ \%$, $4\ \%$, $8\ \%$ and $12\ \%$ and released.

Then, to calculate the conductivity of each sample, we used a diameter of $1.1\ mm$ in the Eq. 3 between 0 and $4\ \%$, $0.95\ mm$ between 4 and $8\ \%$, $0.92\ mm$ between 8 and $12\ \%$ and $0.89\ mm$ for higher strains until failure.

The decrease of the diameter measured when increasing the strain of a cotton yarn had a moderate influence on the calculated conductivity. At the rupture of the yarn, the conductivity was $1.3\ S/cm$ when the variation of the diameter was implemented in Eq. 4 and $1.1\ S/cm$ when it was not so that the curves have a similar behavior (Fig. S3).

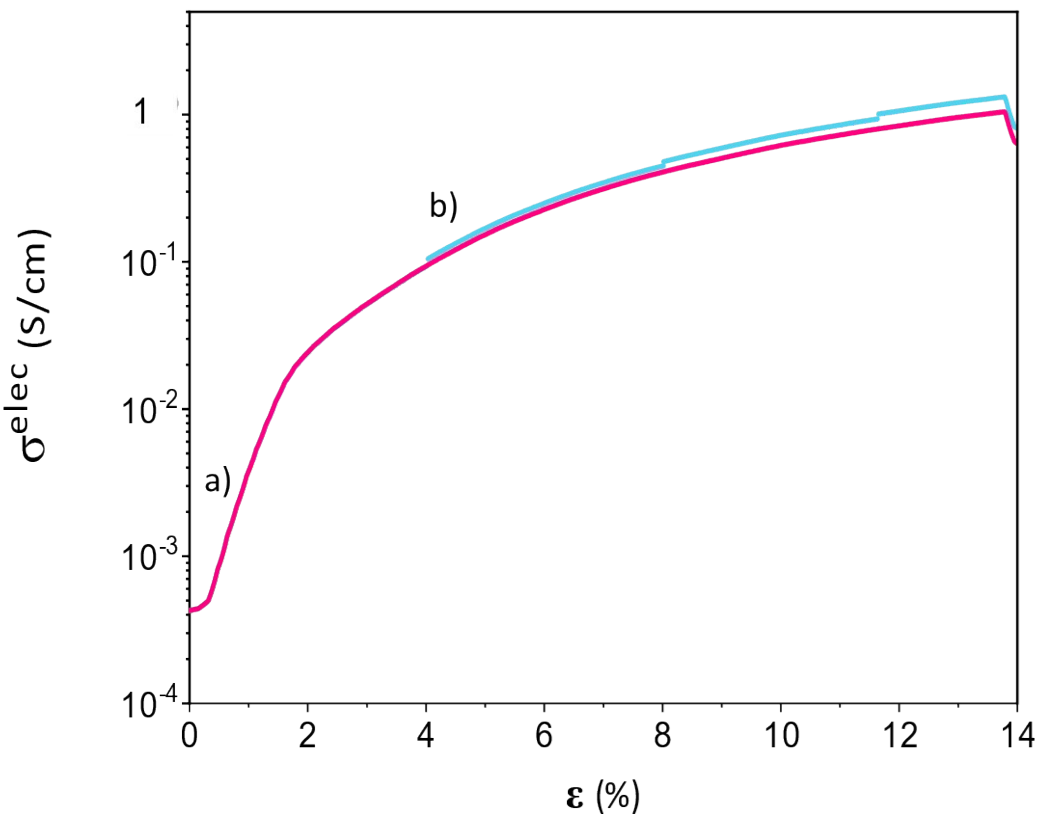

Figure S3: Influence of strain onto the G-coated yarn electrical conductivity a) including a yarn diameter change and b) without yarn diameter change

We did not find a method to measure the diameter in live during the elongation. Nevertheless, it should be mentioned that we focused our attention on the evolution of the conductivity along the strain that is why we do not to include the change in diameter in the calculation of the conductivity.

2. **Raman spectrum, TGA thermogram and SEM images of G powder and G-coated cotton yarn**

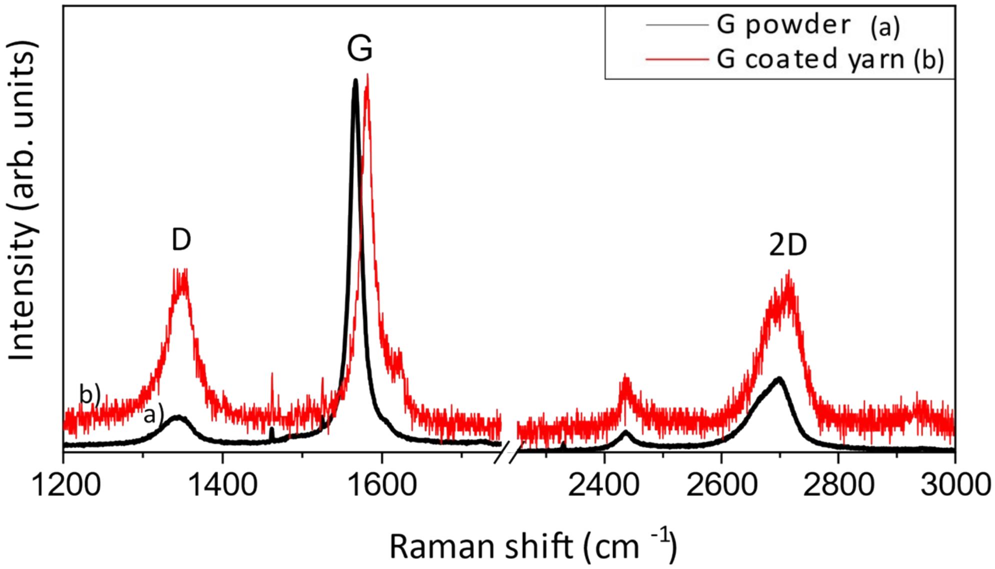

Figure S4: Raman spectrum of a) G powder and b) G-coated cotton yarn at 532 nm

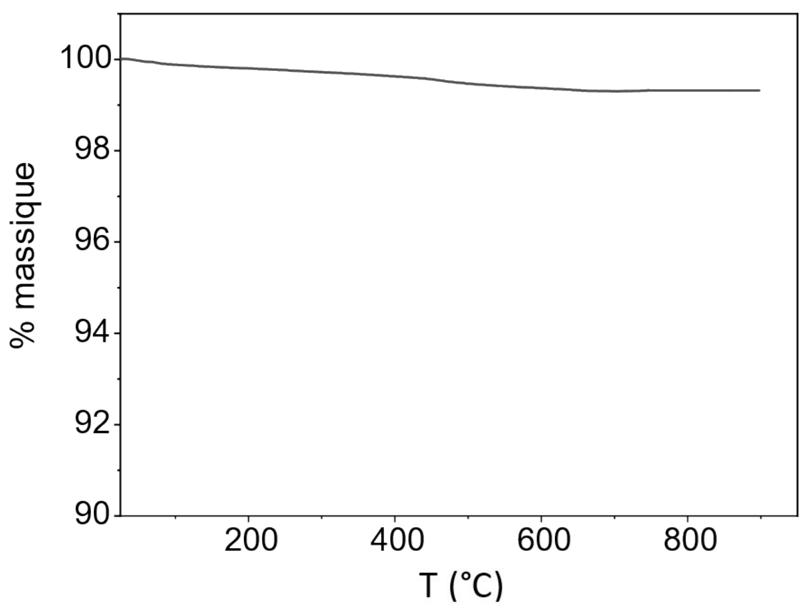

Figure S5: TGA thermogram under nitrogen atmosphere of G powder

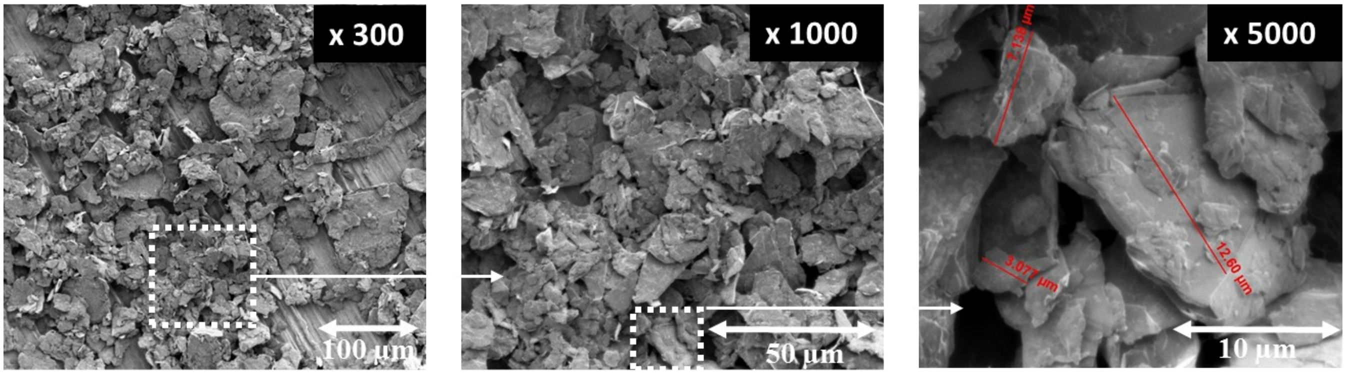

Figure S6: SEM images of G flakes at magnification 300, 1000 and 5000

3. Amount of deposited Graphene sheets on the yarns

The deposited amount of Graphene sheets on the cotton yarns was determined by TGA. The average value was calculated from five 3 cm long samples at 600 °C (Fig. S4) using Eq. 4 (see experimental part). The average amount of deposited graphene sheets onto the cotton yarns was 14.3 ± 0.9 %.

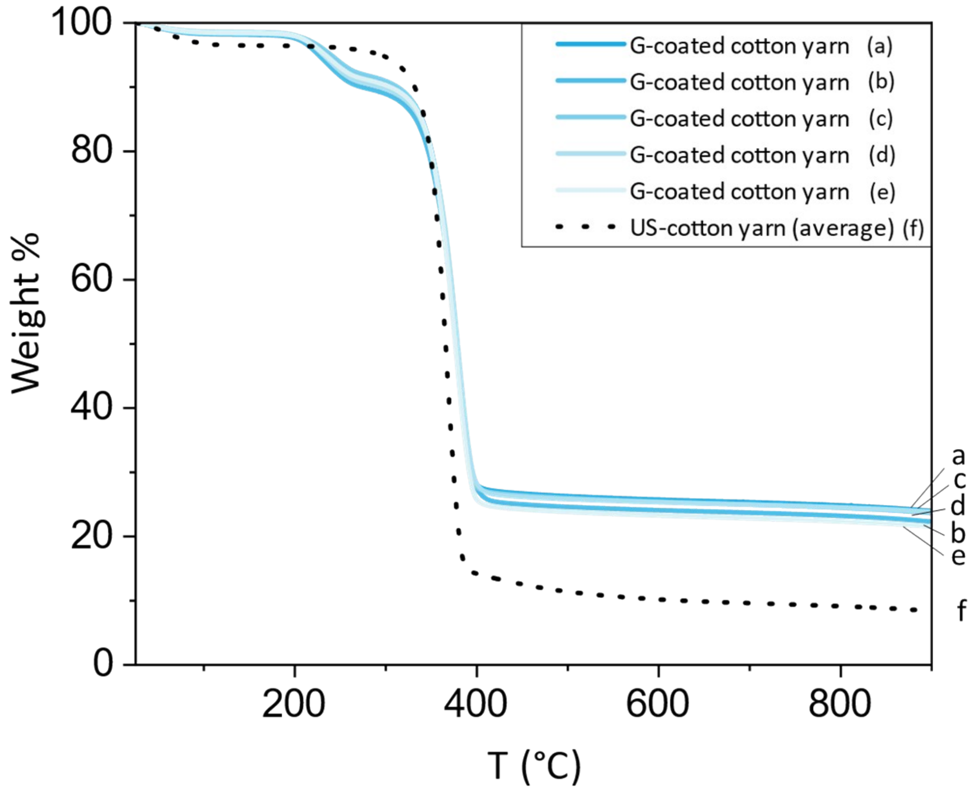

Figure S7: TGA thermograms under nitrogen atmosphere of G coated cotton yarns and average US-treated cotton yarn.

4. Repeatability of the electrical and mechanical measurements

The repeatability of the mechanical and the electrical measurement was evaluated by using 10

Sample	σ_{ini}^{elec} (S/cm)	σ_{break}^{elec} (S/cm)	σ_{break}^{meca} (MPa)	ε_{break} (%)
1	1.8×10^{-5}	1.53	39	15
2	1.1×10^{-2}	1.26	41	14
3	1.1×10^{-4}	1.79	38	13
4	1.8×10^{-3}	0.73	38	14
5	1.4×10^{-3}	0.60	40	11
6	4.0×10^{-3}	0.70	42	11
7	7.4×10^{-5}	0.90	39	14
8	1.1×10^{-2}	0.89	41	9
9	4.1×10^{-2}	1.79	39	14
10	7.3×10^{-3}	0.88	40	12

samples (Table S1).

Table S1: Electrical and mechanical properties of G coated cotton yarn.

They were prepared on the same day in the same experimental conditions. It was observed that the electrical conductivity values were not reproductible when no deformation was applied (in the range 7×10^{-5} to $4 \times 10^{-2}\ S/cm$). We explained the disparity with the natural structuration of cotton yarn: it is not consistent along the bobbin so that some part might be not as tight as others. Under uniaxial deformation, the conductivity increased continuously until reaching a maximum at break (Fig. 7). The average value was $1.11 \pm 0.39\ S/cm$.