SUPPORTING INFORMATION

Electroconductive and biocompatible hydrogels based on gelatin and PEDOT:PSS for a mini-invasive approach in neural tissue regeneration

Franco Furlani[1*], Margherita Montanari[1], Nicola Sangiorgi[1], Emanuela Saracino[2], Elisabetta Campodoni[1], Alessandra Sanson[1], Valentina Benfenati[2], Anna Tampieri[1], Silvia Panseri[1], and Monica Sandri[1*]

[1] National Research Council of Italy - Institute of Science and Technology for Ceramics (ISTEC-CNR), Via Granarolo 64, I – 48018, Faenza (RA), Italy

[2] National Research Council of Italy - Institute of Organic Synthesis and Photoreactivity (ISOF-CNR), Via Gobetti, 101, I – 40129, Bologna, Italy

*** Corresponding authors**

E-mail: franco.furlani@istec.cnr.it

monica.sandri@istec.cnr.it

Gelatin % (w/w respect to the total weight of the sample)	Genipin % (w/w respect to gelatin)	Gelation (yes/no)
5	0.25	no
5	0.5	no
5	1	no
10	0.1	no
10	0.2	no
10	0.5	no
10	1	yes

Table S1. Composition of samples tested. Concentrations of gelatin, genipin and features of resulting samples at 37°C are reported.

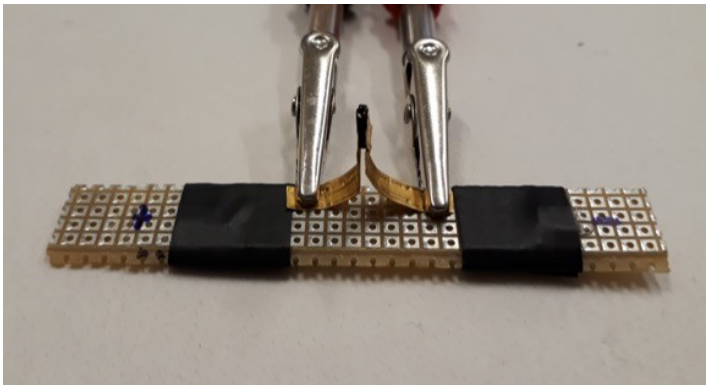
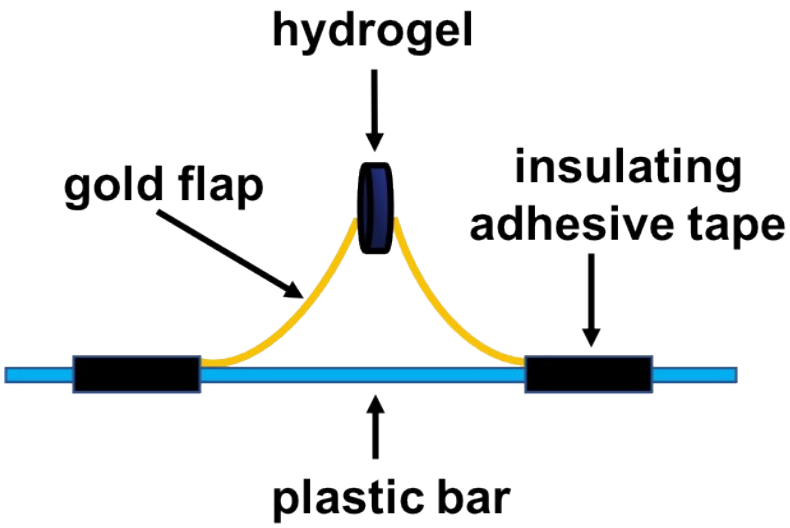


Figure S1. Experimental set-up used for Electrochemical Impedance Spectroscopy (EIS) analyses. The electroconductive hydrogel sample was tested between the gold electrodes. Experimental conditions: [gelatin] = 10% (w/w respect to the total weight of the sample), [genipin] = 0.1% (w/w respect to gelatin), and [PEDOT:PSS] = 0.3% (w/w respect to the total weight of the sample).



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35 **Scheme S1.** Schematic representation of experimental set-up used for Electrochemical Impedance
36 Spectroscopy analyses.

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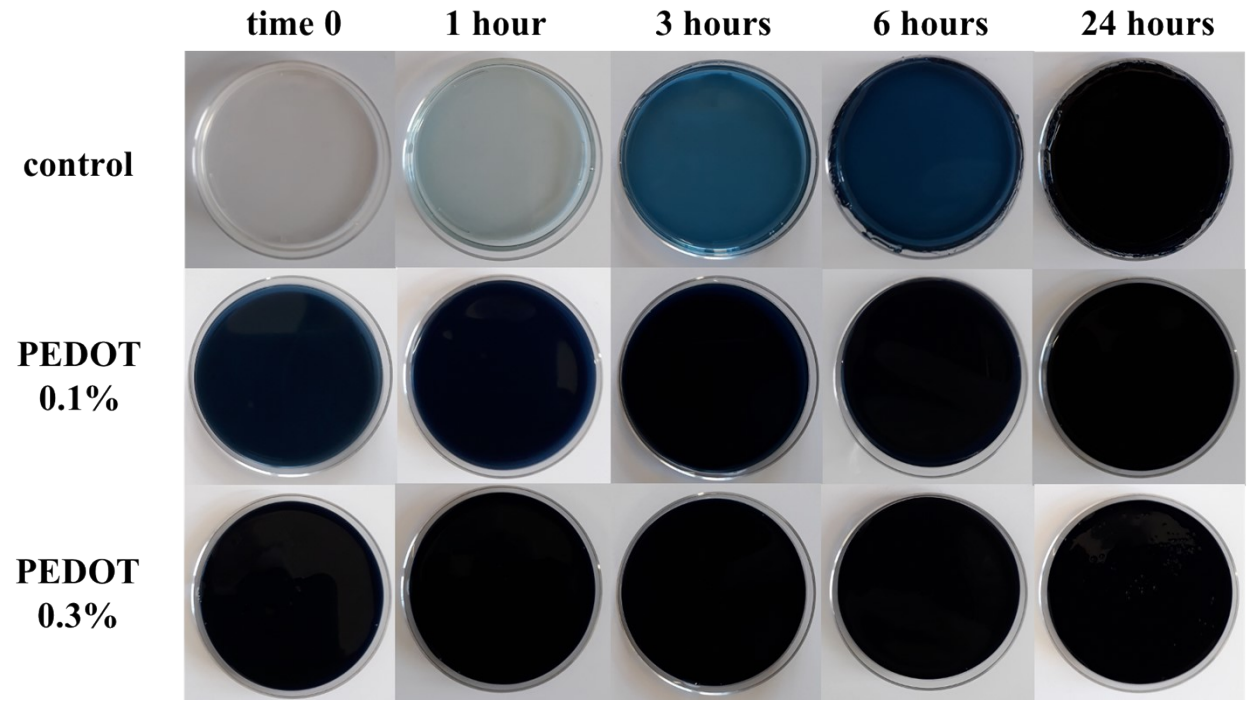

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39 **Figure S2.** Visual analyses of gelatin-based matrices at different timeframes, *i.e.* immediately after genipin
40 addition (time 0) and after 1, 3, 6 and 24 hours. Experimental conditions: [gelatin] = 10% (w/w respect to the
41 total weight of the sample), [genipin] = 1% (w/w respect to gelatin), and [PEDOT:PSS] = 0 - 0.3% (w/w
42 respect to the total weight of the sample), T = 37 °C.

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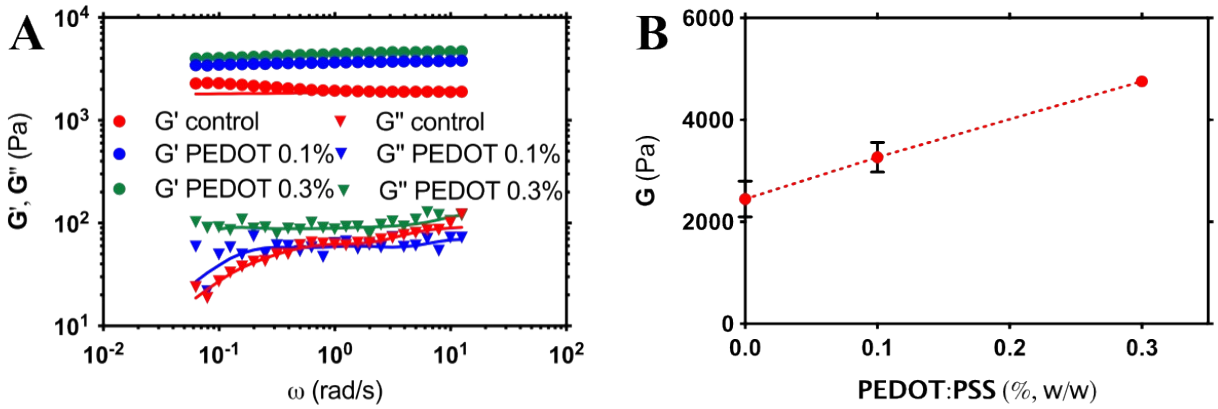

Figure S3. Mechanical characterization by rheology. **(A)** Dependence of storage (G', circles) and loss moduli (G", triangles) on angular frequency, ω, for gelatin-based hydrogels with different amounts of PEDOT:PSS: [PEDOT:PSS] = 0% (w/w) (red), [PEDOT:PSS] = 0.1% (w/w) (blue), and [PEDOT:PSS] = 0.3% (w/w) (green). Solid lines are the best fit of experimental points according to eq. 1 and 2. **(B)** Dependence of the shear modulus, G, on the amount of PEDOT:PSS. G values were determined according to eq. 3. data are reported as means ± standard deviations (SD) of at least three measurements. The dotted line is drawn to guide the eye. Experimental conditions: [gelatin] = 10% (w/w respect to the total weight of the sample), [genipin] = 1% (w/w respect to gelatin), and [PEDOT:PSS] = 0 - 0.3% (w/w respect to the total weight of the sample), T = 37 °C.

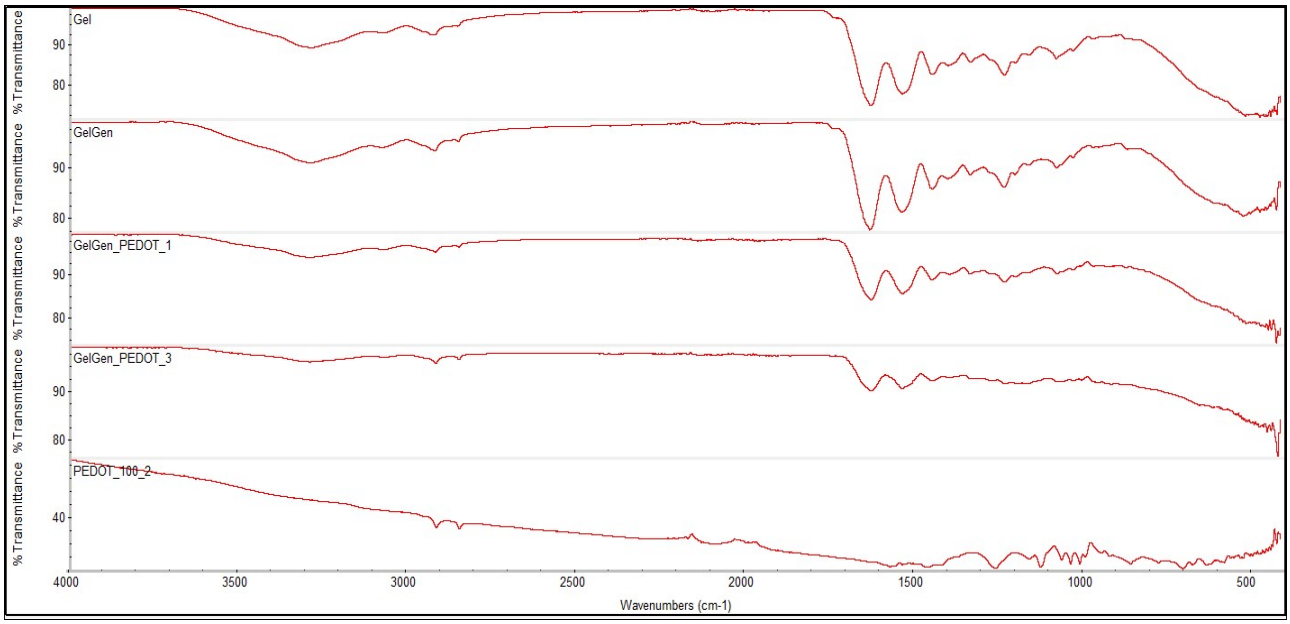

Figure S4. Stacked FTIR-ATR of freeze-dried samples. From the top to the bottom are reported samples based on gelatin (Gel), genipin-crosslinked gelatin (GelGen), genipin-crosslinked gelatin (GelGen) with PEDOT:PSS = 0.1% w/w (GelGen_PEDOT_1), genipin-crosslinked gelatin (GelGen) with PEDOT:PSS =

0.3% w/w (GelGen_PEDOT_3), and pure PEDOT:PSS (PEDOT_100_2).

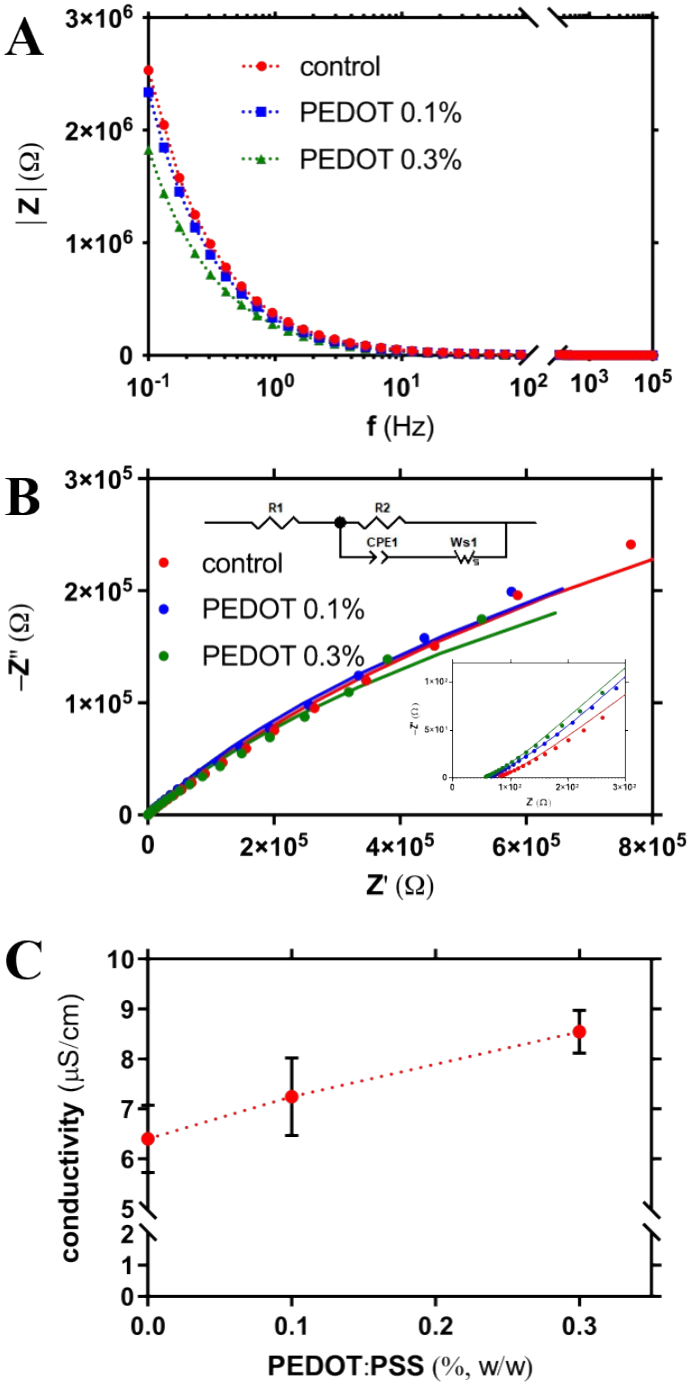

Figure S5. (A) Electrochemical Impedance Spectroscopy measurements of gelatin-based hydrogels with different amounts of PEDOT: [PEDOT:PSS] = 0% (w/w) (red), [PEDOT:PSS] = 0.1% (w/w) (blue), and [PEDOT:PSS] = 0.3% (w/w) (green). **(B)** Nyquist plot for gelatin-based hydrogels with different amounts of PEDOT: [PEDOT:PSS] = 0% (w/w) (red), [PEDOT:PSS] = 0.1% (w/w) (blue), and [PEDOT:PSS] = 0.3% (w/w) (green). Colored solid lines are the best fit of experimental points. **(C)** Dependence of the electronic conductivity on the amount of PEDOT. Data are reported as means ± standard deviations (SD) of seven measurements. All dotted lines are drawn to guide the eye. Experimental conditions: [gelatin] = 10% (w/w respect to the total weight of the sample), [genipin] = 1% (w/w respect to gelatin), and [PEDOT:PSS] = 0 - 0.3% (w/w respect to the total weight of the sample), PBS 1X as solvent, T = room temperature.

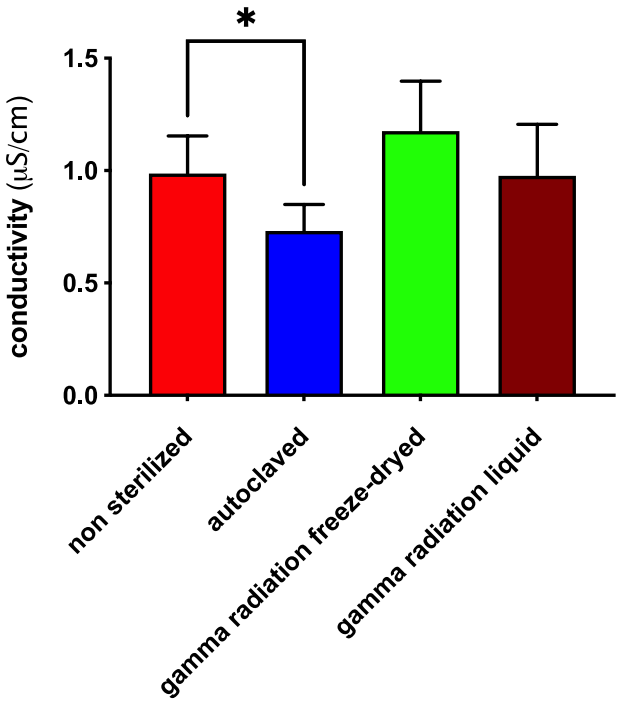

Figure S6. Dependence of conductivity on different sterilization techniques for PEDOT:PSS. Experimental conditions: [gelatin] = 10% (w/w respect to the total weight of the sample), [genipin] = 1% (w/w respect to gelatin), and [PEDOT:PSS] = 0.3% (w/w respect to the total weight of the sample). One-way ANOVA followed by Dunnett post-hoc test was performed to compare all groups (*: p value < 0.05). In all cases, data are reported as means ± standard deviations (SD) of at least five measurements.

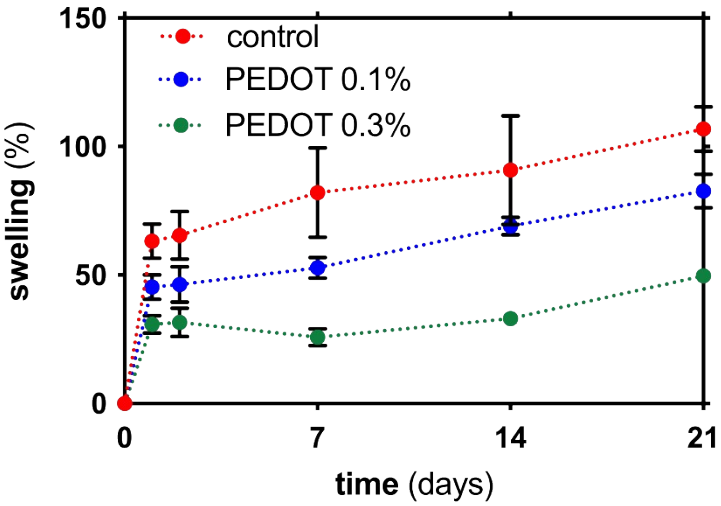

Figure S7. Dependence of swelling, *i.e.* PBS uptake, on time of gelatin-based hydrogels with different amounts of PEDOT:PSS: [PEDOT:PSS] = 0% (w/w) (red), [PEDOT:PSS] = 0.1% (w/w) (blue), and [PEDOT:PSS] = 0.3% (w/w) (green). Experimental conditions: [gelatin] = 10% (w/w respect to the total weight of the sample), [genipin] = 1% (w/w respect to gelatin), and [PEDOT:PSS] = 0 - 0.3% (w/w respect

to the total weight of the sample), T = 37 °C. In all cases, data are reported as means ± standard deviations (SD) of three measurements.

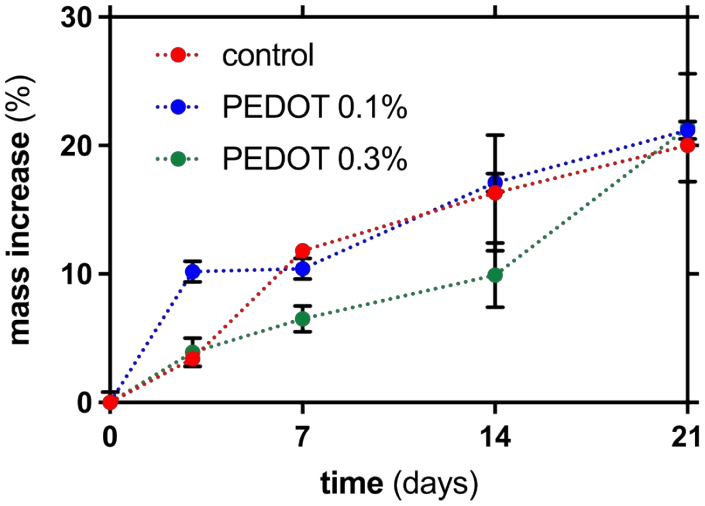

Figure S8. Dependence of mass increase on time of gelatin-based hydrogels with different amounts of PEDOT:PSS: [PEDOT:PSS] = 0% (w/w) (red), [PEDOT:PSS] = 0.1% (w/w) (blue), and [PEDOT:PSS] = 0.3% (w/w) (green). Experimental conditions: [gelatin] = 10% (w/w respect to the total weight of the sample), [genipin] = 1% (w/w respect to gelatin), and [PEDOT:PSS] = 0 - 0.3% (w/w respect to the total weight of the sample), T = 37 °C. In all cases, data are reported as means ± standard deviations (SD) of two measurements.

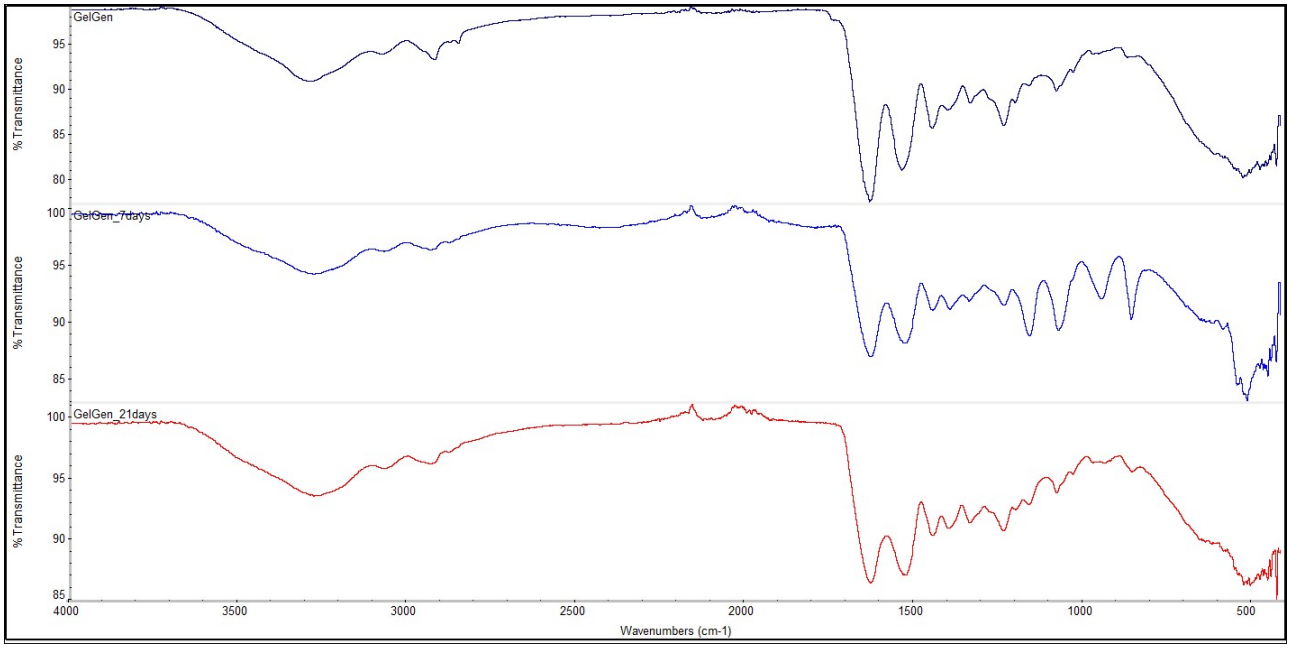

Figure S9. Stacked FTIR-ATR of genipin-crosslinked gelatin hydrogels used for degradation test and freeze-dried. From the top to the bottom are reported samples based on the native sample and the same sample after the incubation for 1 (7 days) and 3 weeks (21 days) in PBS. Experimental conditions: [gelatin] = 10% (w/w respect to the total weight of the sample), [genipin] = 1% (w/w respect to gelatin).

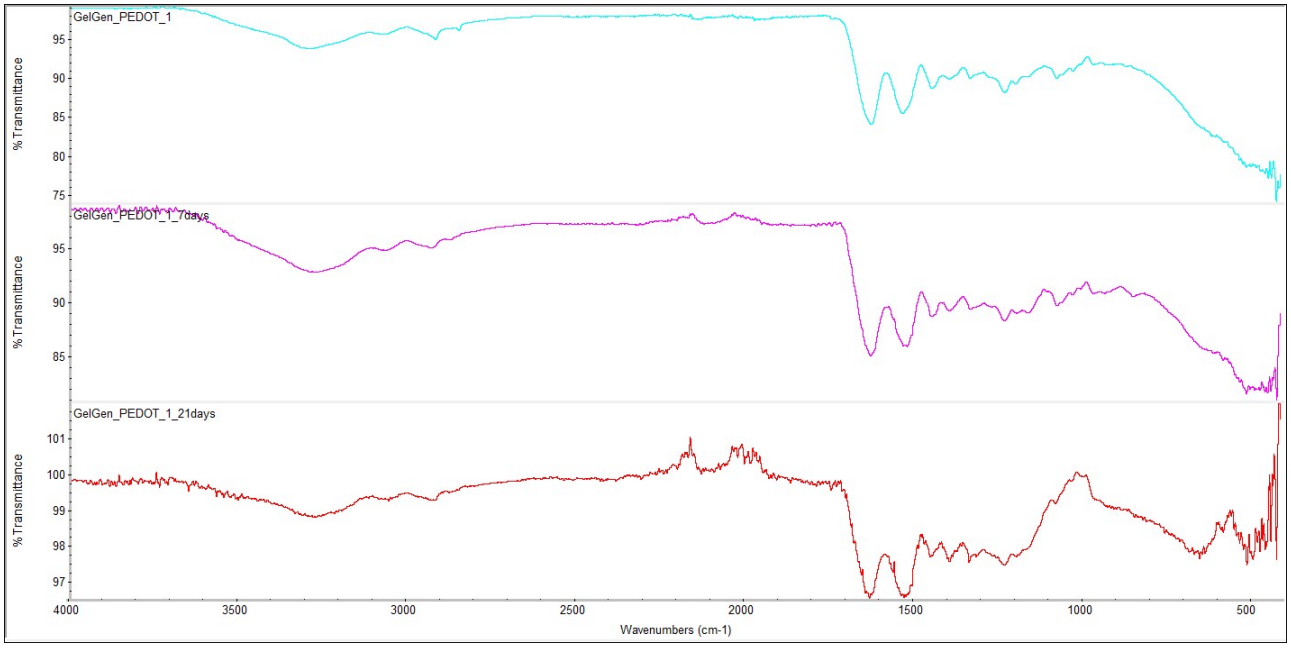

Figure S10. Stacked FTIR-ATR of genipin-crosslinked gelatin hydrogels used for degradation test and freeze-dried. From the top to the bottom are reported samples based on the native sample and the same sample after the incubation for 1 (7 days) and 3 weeks (21 days) in PBS. Experimental conditions: [gelatin] = 10% (w/w respect to the total weight of the sample), [genipin] = 1% (w/w respect to gelatin), and [PEDOT:PSS] = 0.1% (w/w respect to the total weight of the sample).

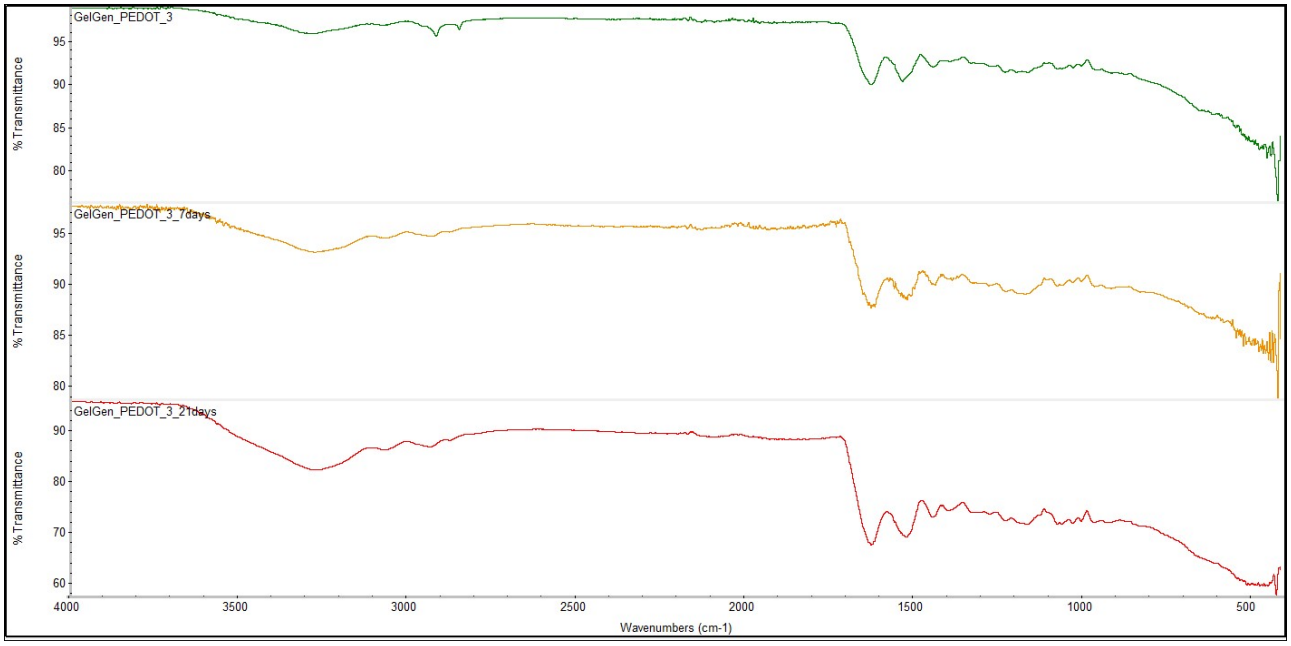

Figure S11. Stacked FTIR-ATR of genipin-crosslinked gelatin hydrogels used for degradation test and freeze-dried. From the top to the bottom are reported samples based on the native sample and the same sample after the incubation for 1 (7 days) and 3 weeks (21 days) in PBS. Experimental conditions: [gelatin] = 10% (w/w respect to the total weight of the sample), [genipin] = 1% (w/w respect to gelatin), and [PEDOT:PSS] = 0.3% (w/w respect to the total weight of the sample).

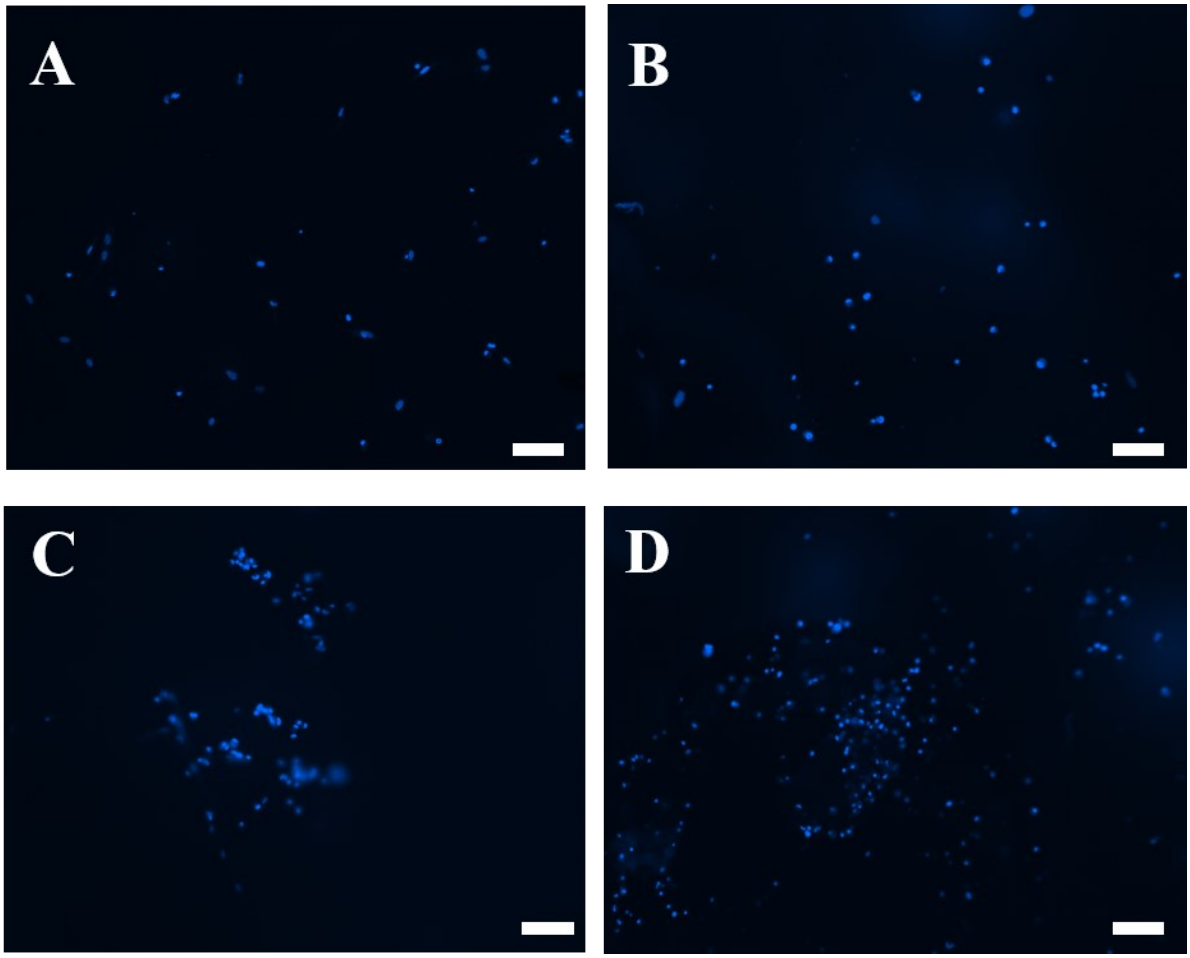

Figure S12. Fluorescence microscopy analyses of astrocytes after 2 **(A, B)** and 7 days **(C, D)** from cells seeding on control hydrogels **(A, C)** and on electroconductive hydrogels **(B, D).** DAPI staining of astrocytes' nuclei is revealed in blue. The scale bar stands for 100 µm for all figures.

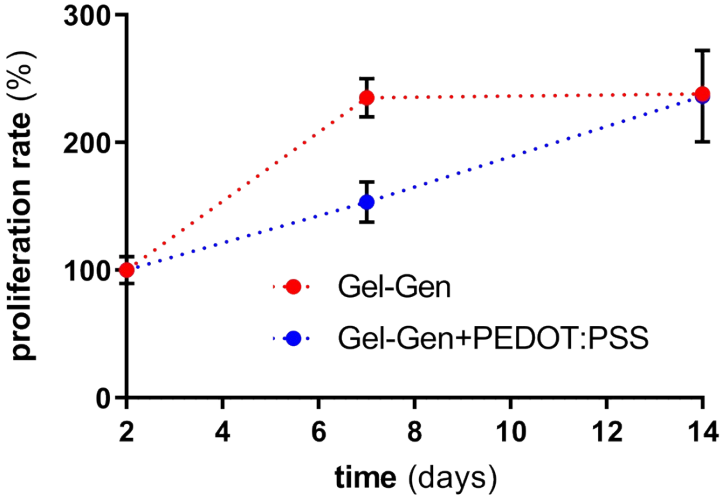

Figure S13. Proliferation rate of astrocytes on electroconductive and control as function of time by Alamar blue assay. Data are plotted as the averaged percentages of reduced AB ± Standard Error (SE).