Electronic Supplementary Material (ESI) for Journal of Materials Chemistry B.

Electronic control of drug release from gauze or cellulose acetate fibres for dermal applications

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Supplementary Information

Ibuprofen calibration curve

To estimate the amount of ibuprofen released in the tests, a calibration curve was obtained using solutions of ibuprofen in water with known concentrations. The absorbance spectra obtained as a function of wavelength (nm) is shown in figure S1. For all solutions similar curves are obtained with the identification of 2 characteristic peaks. One at 222 nm and another variable between 190 nm and 200 nm. As the 222 nm peak is found in the literature [1][2] and the most regular, this peak was chosen to construct the graph with the calibration straight line, inset of figure S1.

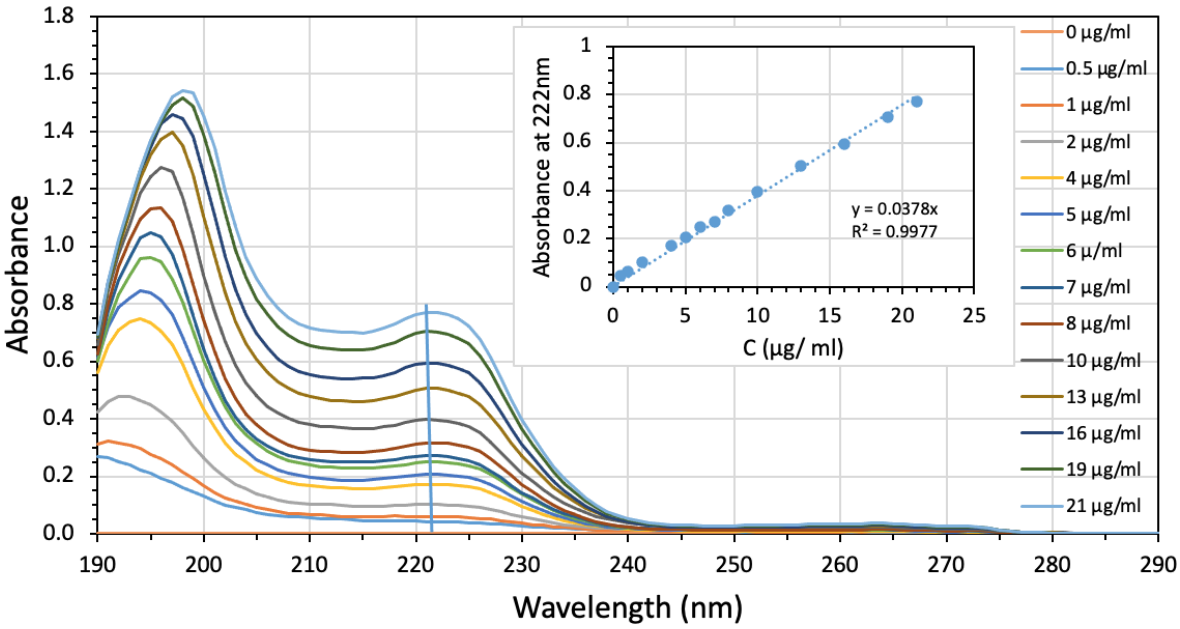

Figure S1: UV absorbance spectra for different aqueous ibuprofen concentration and in the inset the concentration versus absorbance at 222 nm.

Functionalization of gauze membranes

The influence of polymerization time on the conductivity of the gauze membranes are shown in figure S1, planar (Figure S2-A) and transversal (Figure S2-B) conductivity. The conductivity of membranes stored at atmospheric conditions after 3 and 6 months are also shown.

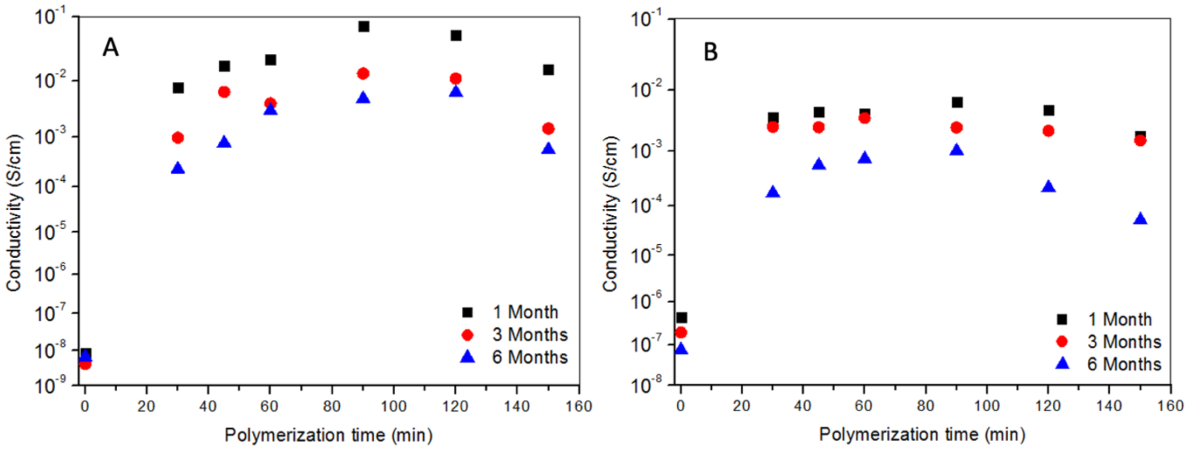

Figure S2: Gauze-Ppy Planar A) and transversal B) conductivity function of the Ppy functionalization time.

As expected, according previous studies performed for cellulose acetate [17], the non-functionalized membranes have a very low conductivity and maximum conductivity is obtained at 90 min functionalization time. A decrease in conductivity of about one order of magnitude after 6 months exposition at air is observed. This happens due oxidation of the Ppy which reduces the positive charges. Brie et al.[3] also found this fact, and Shi et al.[4] suggest that a reaction in the main Ppy chain with oxygen can cause this degradation of conductivity over time, due to contact of samples with air. For polymerization time above 90 min, there is a tendency for conductivity decrease, probably due to the increase of clusters. This behaviour of conductivity with polymerisation time was verified by Sasso et al.[5], using different substances in pyrrole solutions for Ppy formation. They found that substances with a high redox potential quickly oxidised the pyrrole, leading to different ideal polymerisation times. From our results, optimized conductivity values are obtained for polymerisation time between 90 min and 120 min. The transversal conductivity is related to the conductivity between the membrane fibres which on the one hand is inferior to the planar conductivity, but at the same time less influenced by exposure to air. The oxygen present in the air does not reach the internal fibres of the membrane as easily as it does the surface fibres, where the planar conductivity is measured and therefore, the first reaction of oxygen is with the surface of the membrane. After 6 months is noticed a decrease in conductivity but its variation with the polymerisation time behaves similarly to planar conductivity. While the internal fibres have more difficulties in receiving the coating in a uniform way and in a greater quantity and gaps between fibres lead to few points of contact between the polymer, which thus reduces conductivity. Due to transverse conductivity results, the gauze membranes polymerised for 90 min were chosen to teste drug delivery system.

Influence of electric field

Due to the inherent handling and use of fixing electrode system in each test, the material may have allowed electrode movement between essays. Thus, although the applied voltage have always been the same, when changing the distance between electrodes, the electric field varies. The influence of the distance between electrodes on the release of the drug was tested for three fixed distances (0.5 cm; 1 cm and 2 cm) and stimulus of equal potential (-1 V) and duration (1 min). Figure S3, show the results obtained in gauze membranes.

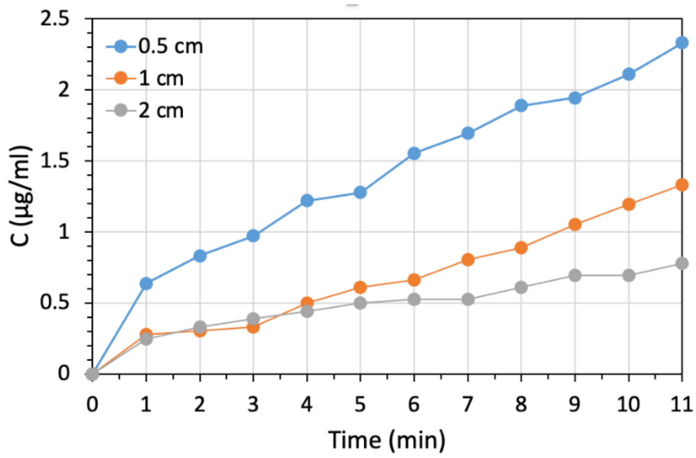

Figure S3: Ibuprofen release profile of gauze membranes with 1 min duration stimuli application and 10 min of total application time for three different electrode-membrane distances.

Two close release profiles can be seen in figure S3, for distances of 1 cm and 2 cm. For the electrode distance of 0.5 cm there is largest release meaning that 2 V/cm is the optimized value for the considered test. This shows that drug release is very sensitive to the electric field and during tests the distance between electrodes must not change otherwise drug release values could be strongly influenced.

References

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