

Electronic Supplementary information (ESI)

Chiral platinum-polypyrrole hybrid films as efficient enantioselective actuators

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Experimental Sections

Mandelic acid encoded mesoporous platinum: Mandelic acid encoded mesoporous platinum was electrodeposited following a literature procedure.¹ The surface of a gold-coated glass slide (2.4 cm × 1.6 cm) was cleaned with piranha solution for 30 min and then rinsed with MilliQ water. It was then covered with a lyotropic liquid crystal, prepared by using nonionic surfactant (Brij 56, 0.75g, 42 wt%), hexachloroplatinic acid (0.525 g, 29 wt%), Milli Q water (0.525g, 29 wt%) and mandelic acid (15.75 mg, 0.03 weight ratio with respect to H₂PtCl₆). After electrodeposition of the mesoporous metal at -0.15 V vs Ag/AgCl with a total charge density of 8 C cm⁻², the chiral platinum layer was rinsed with water over night to remove the template molecules and surfactant.

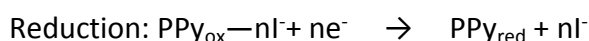
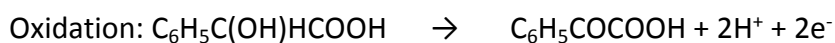
Hybrid PPy-chiral platinum: The as-prepared chiral-encoded mesoporous platinum was modified with a polypyrrole layer following a literature procedure.² A solution composed of pyrrole (140 μl, 0.2M) and sodium dodecylbenzenesulfonate (0.875 g, 0.2 M) in 10 ml MilliQ water was prepared. The previously modified gold plate was immersed and electropolymerization was carried out in a galvanostatic mode at 3.6 mA for 5400 s. The resulting hybrid material was cleaned with water, and then peeled off by immersing it in a KI/I₂ solution for 2 days in order to etch away the underlying gold layer. Afterwards the PPy-Pt film was rinsed with water to remove adsorbed I₂ and KI for 4 hr.

Enantioselective actuator: A piece of the hybrid PPy-Pt film with dimensions of 1 mm × 6 mm × 50 μm (PPy) and 5 mm × 5 mm × 50 μm (Pt+PPy) was fixed on an inert support at the center of the electrochemical cell (see Scheme 1c). Two graphite electrodes with 10 mm diameter were used as feeder electrodes in the bipolar electrochemical set-up. The cell was filled with a solution of 50 mM mandelic acid in 50 mM HCl. A potential of 5.3 V was applied between

the feeder electrodes for the actuation experiment and simultaneously a video was recorded by using a microscope (LEICA AZ16 APO).

Chiral recognition mechanism

As illustrated in Scheme 1c, the chiral actuator obtained by electrodeposition and electropolymerization composed of two components, namely chiral encoded Pt and PPy, is triggered by electrochemical reactions in the presence of an external electric field applied by two feeder electrodes. The redox processes occurring at the extremities of the hybrid PPy-Pt material in a mandelic acid solution are described by the following equations ³:



When applying the potential, the oxidation of mandelic acid occurs at the positively polarized chiral imprinted Pt surface. On the other hand, the reduction of polypyrrole takes place at the negatively polarized side of the oxidized polypyrrole strip. The change in redox state during electroactuation is compensated by the release of iodide ions. The reduction of polypyrrole and the release of iodide is directly and quantitatively correlated with the oxidation of chiral mandelic acid at the imprinted platinum side. In the case of R-mandelic acid imprinted Pt-PPy, the R enantiomer is preferentially oxidized at the encoded platinum as can be seen from the Differential Pulse Voltammogram in Figure S3. This can be attributed to a more favorable partition coefficient for this enantiomer between the solution and the porous metal phase, comparable to the behavior of a selective sponge [1]. These higher currents translate on the bipolar object into a faster bending of the polymer [2]. In the present case the chiral selectivity can then be deduced from the difference in relative bending:

$$\text{Relative bending} = \frac{\text{Bending distance for the studied enantiomer at a given time}}{\text{Final bending distance for the imprinted enantiomer}}$$

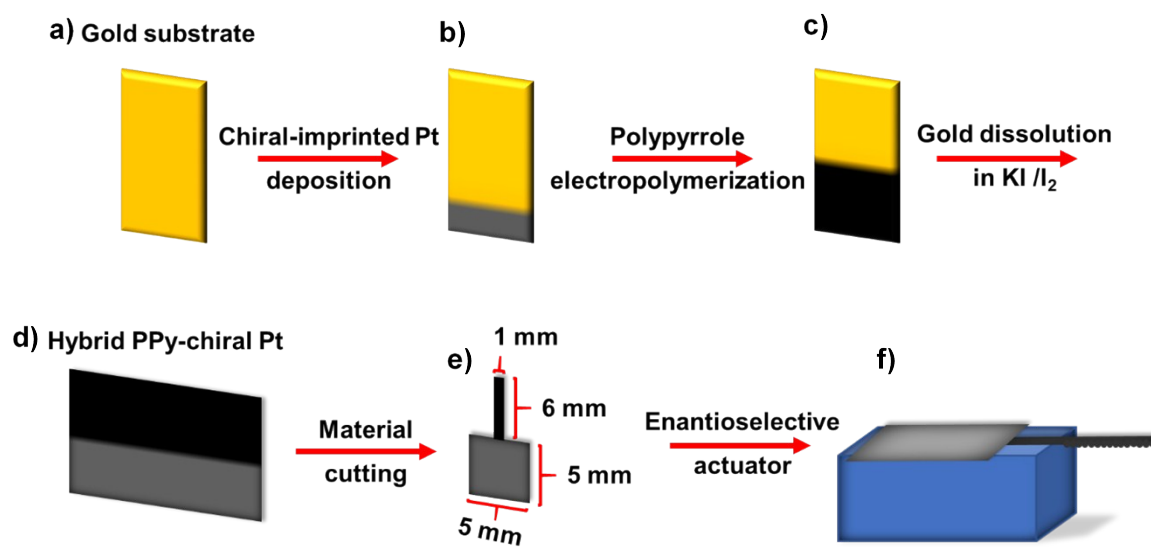


Fig. S1 Preparation scheme of a hybrid chiral Pt-PPy film a) gold substrate; b) chiral-imprinted Pt partially covering the gold coated glass slide; c) hybrid film on gold substrate; d) free-standing hybrid film after etching of the gold layer; e) tailored final geometry of the actuator f) enantioselective actuator mounted on a rubber support.

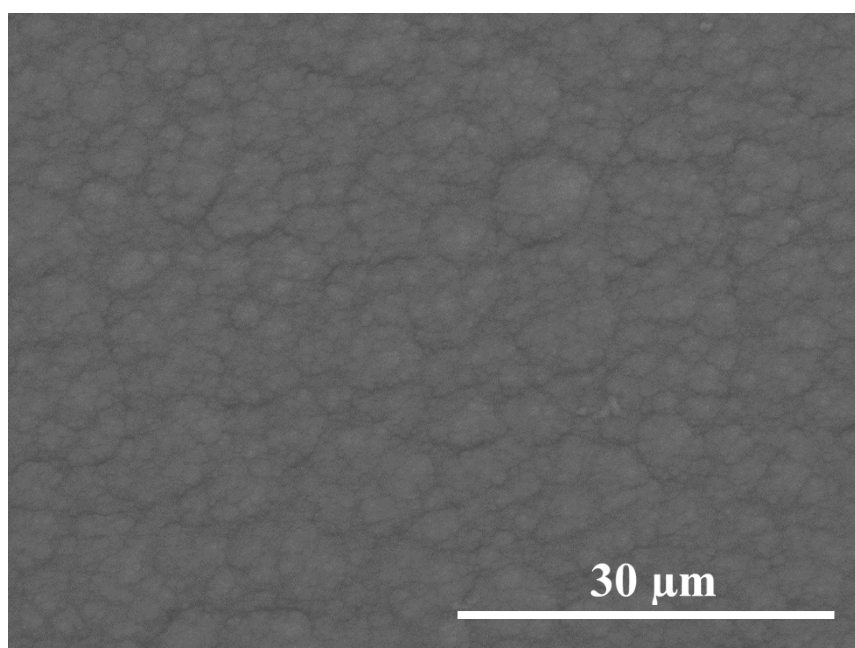


Fig. S2 SEM image of the rough bottom face of the free-standing hybrid PPy-Pt material.

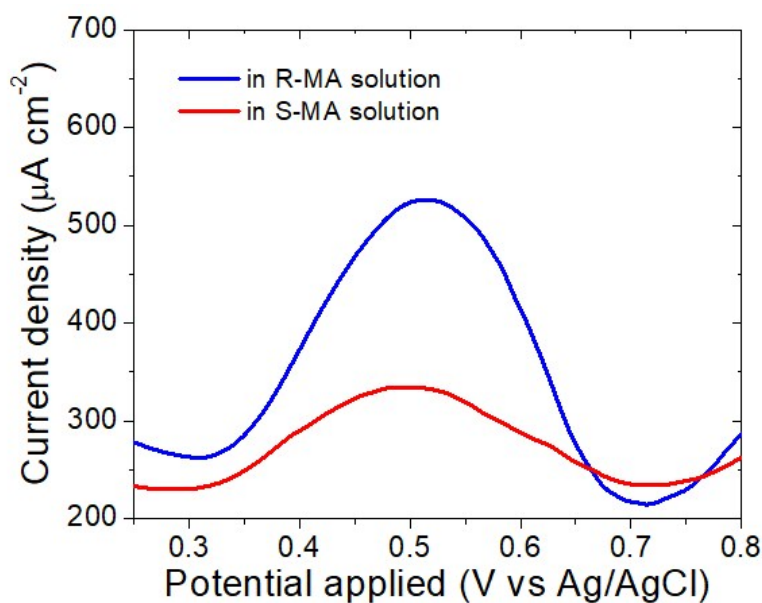


Fig. S3 Differential Pulse Voltammetry of R-MA imprinted Pt-PPy in 50 mM R-MA (blue) and S-MA (red) using 50 mM HCl as supporting electrolyte.

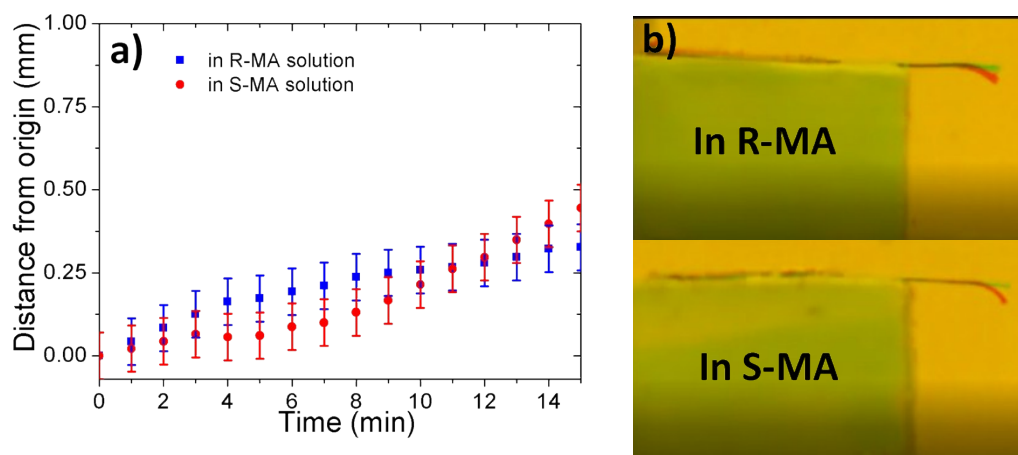


Fig. S4 (a) Bending as a function of time for non-imprinted Pt-PPy in 50 mM R-MA (blue) and S-MA (red) using 50 mM HCl as supporting electrolyte. (b) Images of non-imprinted hybrid PPy-Pt during chiral analysis in R-MA (top) and S-MA (bottom) at the beginning (green) and after 15 min (red).

Associated references

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