Access to Highly Tough Hydrogels by Polymer Modules for Application of Catalytic Reactors

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Table S1. The melting temperature, crystallinity and melting enthalpy calculated from DSC curves of PVA/PAA–T hydrogels prepared at different annealing temperatures. All hydrogels are fabricated with PAA content of 1 wt% and annealing for 1 h.

<table>
<thead>
<tr>
<th>Annealing temperature / °C</th>
<th>$T_m$ /°C</th>
<th>$\Delta H$ / (J g$^{-1}$)</th>
<th>Crystallinity (%)</th>
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<td>215.41</td>
<td>54.32</td>
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Figure S1. Three view drawing of designed Fenton-reactor. (a) Front view; (b) lateral view; (c) top view; (d) photographs of reactor mold.
**Figure S2.** (a) Time-dependent FT-IR spectra of the PVA/PAA hydrogels with PAA content of 1 wt% under annealing temperature (130 °C) in the time range of 0 - 90 min; (b) enlarged view from 1600 to 2000 cm⁻¹ of (a).
Figure S3. (a) FT-IR spectra of the PVA/PAA-T hydrogels and the PVA/PAA-T-NaOH hydrogels (the PVA/PAA-T hydrogel treated with 1 M NaOH solution for 7 days); (b) enlarged view from 1600 to 2000 cm$^{-1}$ of (a).
Figure S4. Optical microscope of PVA/PAA-T hydrogels before and after annealing at 130 °C for 120 min.
Figure S5. (a) The tensile stress-strain curves of PVA/PAA-T-Fe$^{3+}$ hydrogels prepared at different annealing temperatures; (b) breaking strains and breaking stress changes over annealing temperatures; (c) toughness and (d) elastic modulus of PVA/PAA-T-Fe$^{3+}$ hydrogels as function of annealing temperatures. All hydrogels are fabricated with PAA content of 1 wt% and treated with 0.1 M Fe$^{3+}$ solution.
Figure S6. DSC Curves of PVA/PAA-T hydrogels prepared with different annealing temperatures.

All hydrogels with PAA content of 1 wt% are treated with annealing at for 1 hour.
Figure S7. (a) X-ray diffraction profiles of the PVA/PAA-T hydrogel prepared with different PAA contents; All hydrogels are treated with annealing at 130 °C for 1 hour; (b) X-ray diffraction profiles of the dried PVA/PAA-T hydrogel with different annealing temperatures for 1 hour. All hydrogels are fabricated with PAA content of 1 wt%.
Figure S8. (a) The tensile stress-strain curves of PVA/PAA-T-Fe$^{3+}$ hydrogels prepared with different molecular weights of PAA; (b) breaking strains and breaking stress changes over molecular weights of PAA; (c) toughness and (d) elastic modulus of PVA/PAA-T-Fe$^{3+}$ hydrogels as function of molecular weights of PAA. All hydrogels are treated with annealing at 130 °C for 1 hour and 0.1 M Fe$^{3+}$. 
Figure S9. (a) The tensile stress-strain curves of PVA/PAA-T-M$^{n+}$ hydrogels prepared with different types of metal cation; (b) breaking strains and breaking stress changes over types of metal cation; (c) toughness and (d) elastic modulus of PVA/PAA-T-M$^{n+}$ hydrogels as function of types of metal cation. All hydrogels are fabricated with PAA content of 1 wt%, annealing at 130 °C for 1 hour and treated with 0.1 M M$^{n+}$ solution.
Figure S10. Photographs of Fenton reaction over different samples (Blank, PVA/PAA-T hydrogels, PVA/PAA-T-Fe$^{3+}$ hydrogels).
Figure S11. UV-vis absorption spectra of the dye solutions incubated in the reactors made by (b) PVA/PAA-T-Fe$^{3+}$ hydrogels and (c) PVA/PAA hydrogels; (d) degradation of MO in different containers.
**Figure S12.** Molecular structures of methylene blue (MB).

**Figure S13.** (a) Photograph of Fenton reaction performed by PVA/PAA-T-Fe$^{3+}$ hydrogels; (b) the catalytic degradation of MB under catalyzed by hydrogels over time; (c) renewability of the hydrogels for the catalytic degradation of MB. All Fenton reactions: 5 mg/L MB, initial pH of 5.96, 0.60 g of hydrogels and room temperature. The control experiment is carried out in the absence of hydrogels.