Electronic Supplementary Material (ESI) for Chemical Science.

Tandem reactions in self-sorted catalytic molecular hydrogels

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1) Synthesis:

The hydrogelators were synthesized following the protocols in the below mentioned articles.

ProValDoc	F. Rodríguez-Llansola, J. F. Miravet, and B. Escuder, *Chem. Commun.*,**2009**, 7303
ProVal8	F. Rodríguez-Llansola, B. Escuder, J. F. Miravet, *Org. Biomol. Chem.***2009**, *7*, 3091–3094
SucVal8	M. Fontanillo et al.,*J. ColloidInterf. Sci.*, **2013**,412, 65–71

2) Gels formation:

ProValDoc: 5.7µmol of the compound was dissolved in 1 mL of water in a screwed tight vial by heating at 100°C followed by sonication for 1minute and left to stand at 25°C.

SucVal8: 7µmol of the compound was dissolved in 1 mL of water in a screwed tight vial by heating at 100°C followed by sonication for 1minute and left to stand at 25°C.

ProVal8: 6 5µmol of the compound was dissolved in 0.8mL of water in a screwed tight vial by heating at 100°C followed by sonication for 1 min and left to stand at 25°C.

ProValDoc+**SucVal8** and **ProVal8**+**SucVal8**: Each component at their respective m.g.c was taken and dissolved in 1 mL of water in a screwed tight vial by heating at 100°C,followed by sonication for 1 minute and left to stand at 25°C.

3) T_{gel} measurement:

Prepared gels were subjected to controlled heating in an oil bath and T_{gel} was determined by inverted vial method to check if the gel still was self-standing. Temperature at which solvent started to liberate from the gel was taken as T_{gel}. Experiments were done in triplicate.

4) Wide angle X-ray Diffraction: Data collection was performed at room temperature with a BrukerD4 Endeavor X-ray powder diffractometer by using Cu Kα radiation. Xerogels were obtained by freeze-drying and lyophilization.

5) Transmission Electron Microscopy:TEM micrographs were obtained using a JEOL 2100 transmission electron microscope. The TEM samples were prepared by directly applying gels at m.g.c on formvar-carbon coated TEM grids. A 5µL droplet of purified water was used to remove the salts and the excess solution was wicked off using filter paper. The samples were immediately stained using 5µl droplet of 1% phosphotungstic acid and was allowed to stand for 5 min. The excess solution was removed using a filter paper. The grids were then left under covered petri dish to dry before obtaining images.

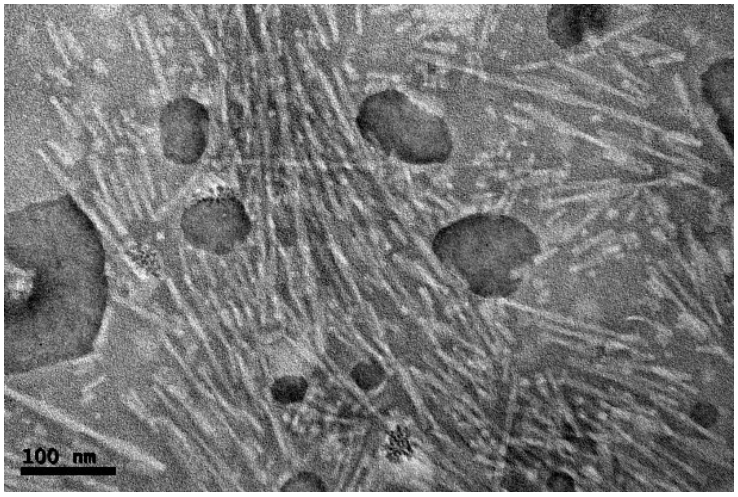


Figure S1. TEM image of **SucVal8** gel.

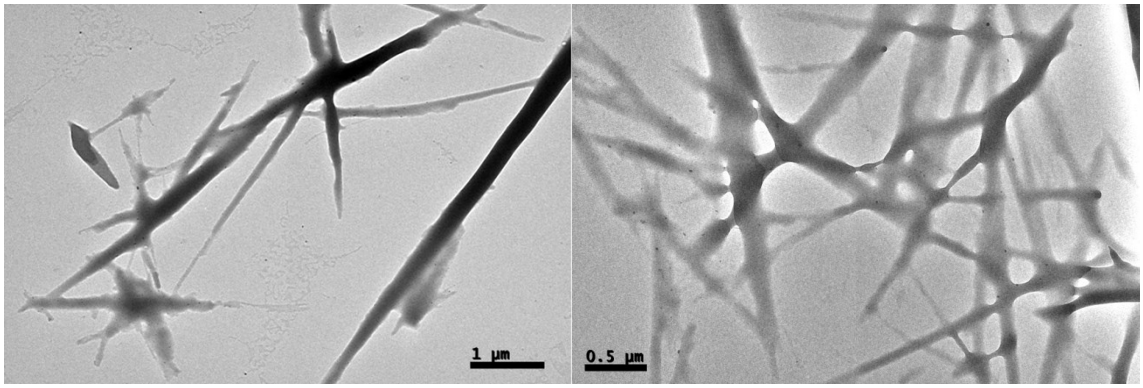


Figure S2. TEM images of **ProValDoc** gel.

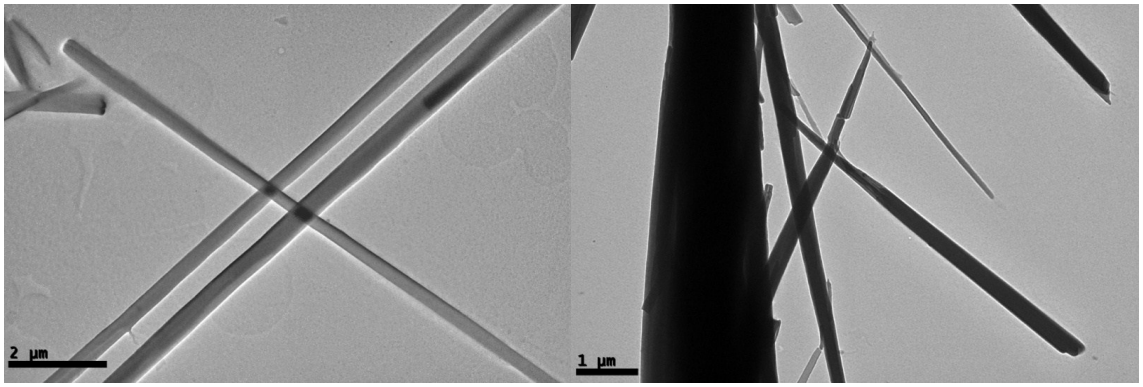


Figure S3. TEM images of **ProVal8**gel.

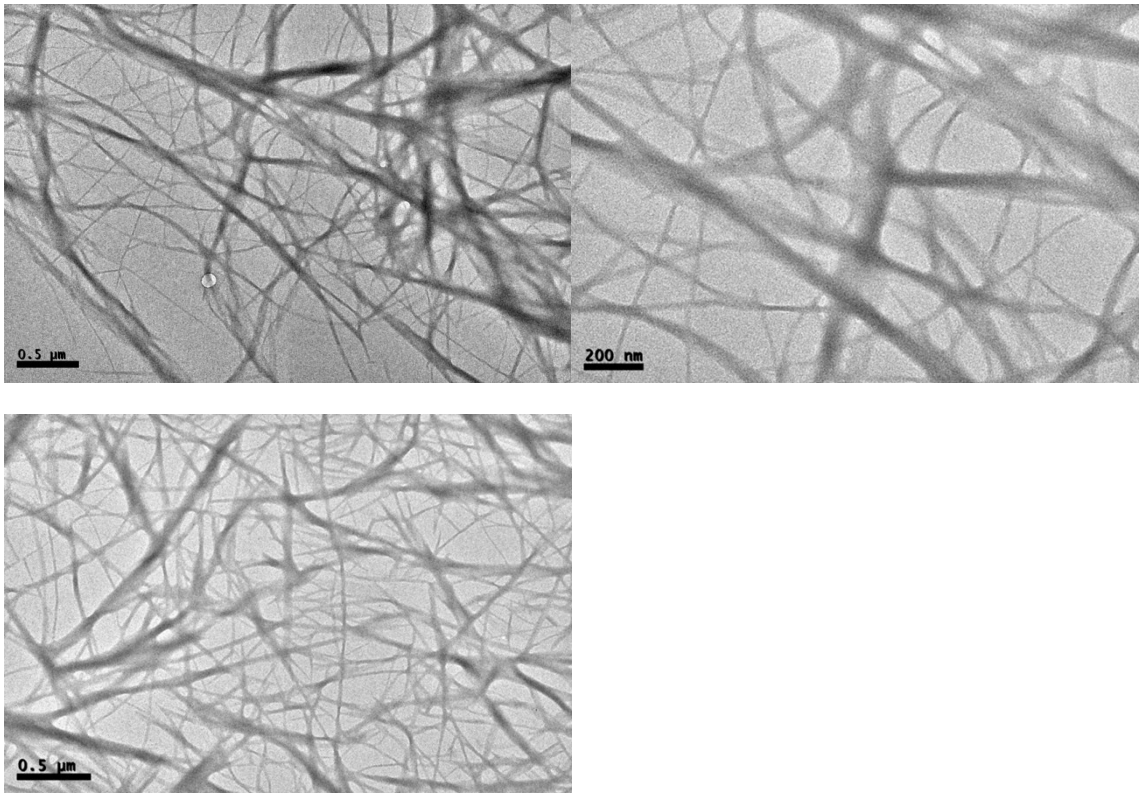


Figure S4. TEM images of **SucVal8+ProValDoc** gel.

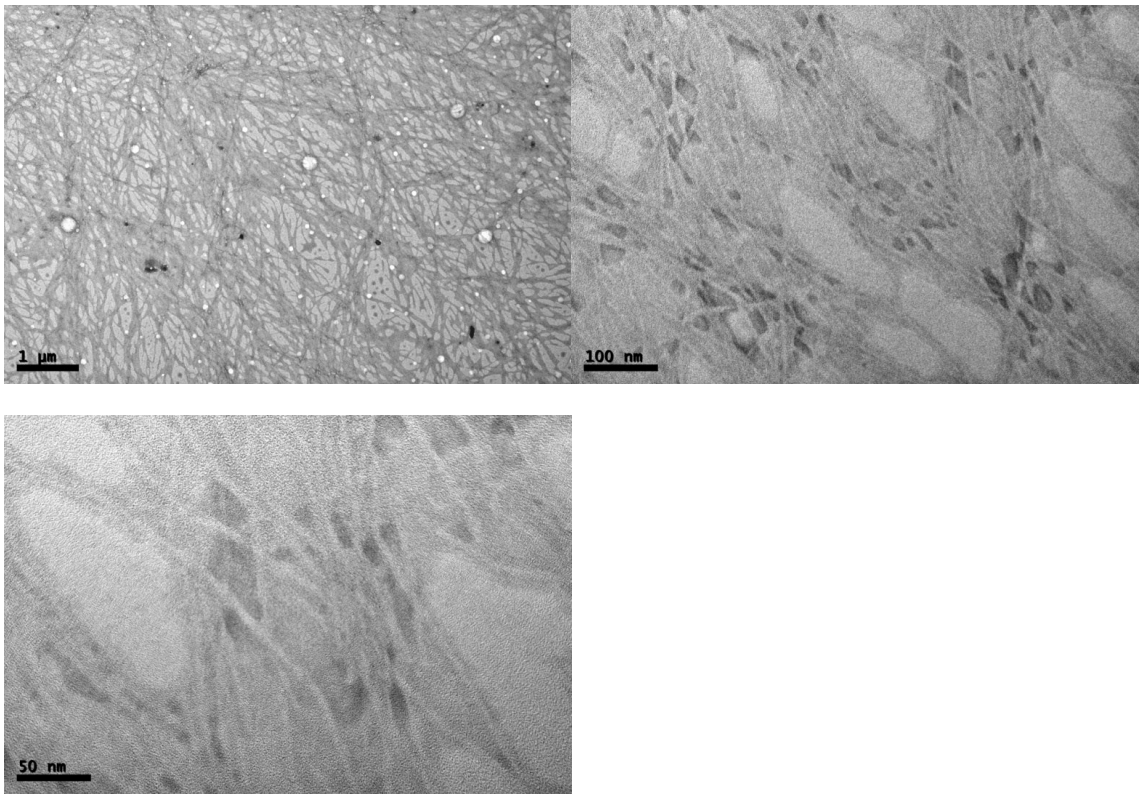


Figure S5. TEM images of **SucVal8+ProVal8**gel.

6) AFM:

In order to visualize the individual fiber structure, atomic force microscopy (AFM) measurements were performed in the tapping mode using a commercial instrument (NTEGRA Prima, NT-MDT Co., Moscow, Russia). Topographic and phase images were recorded simultaneously at scanning rate of 0.4Hz using a rectangular silicon cantilever (NSG03 series) with a resonant frequency of 100kHz (in the air) and force constant of 6.566N/m, which was determined by the thermal fluctuation method[*Rev. Sci. Instrum*. 64, 1868 (1993)].
For samples preparation, diluted fiber solution was spin-coated on the surface of silicon wafers (5×7mm). Before spin coating, these small pieces of silicon wafers were cleaned by water, ethanol, and sonication in acetone followed by plasma treatment for 2.5min.

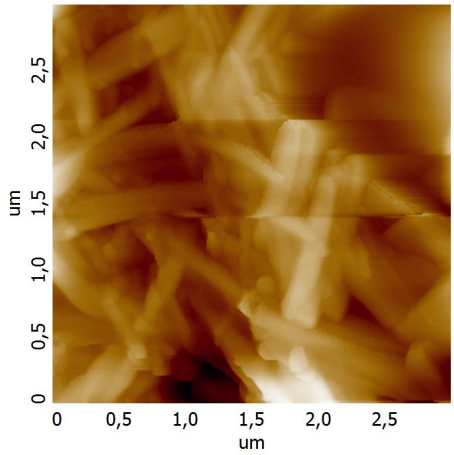


Figure S6. AFM image of **ProVal8**.

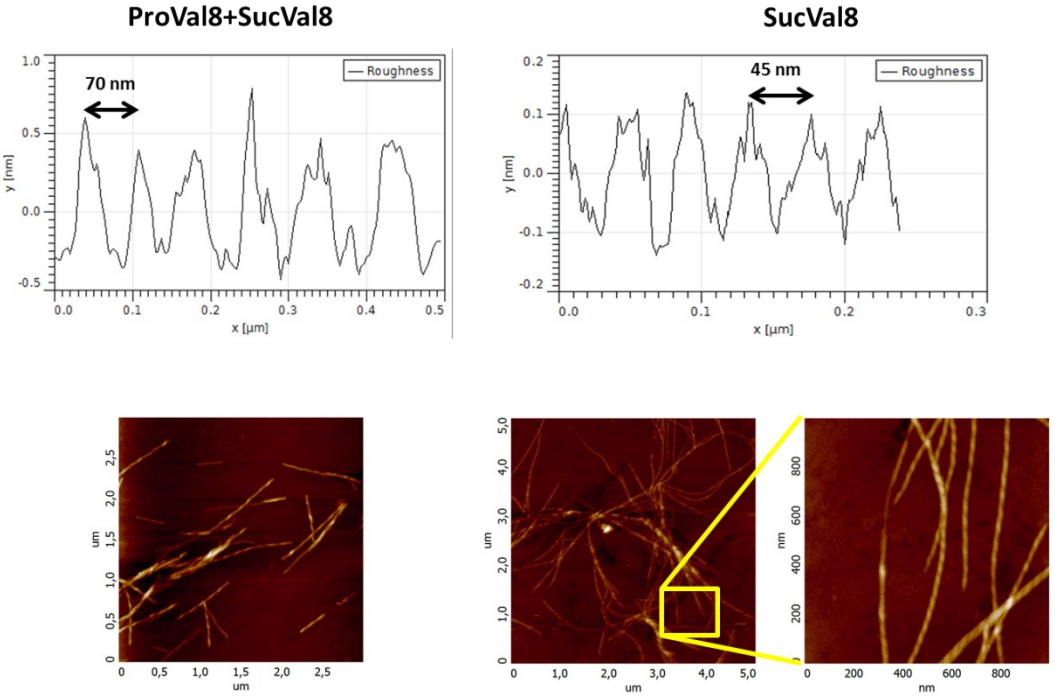


Figure S7. AFM images and height and width profiles for **ProVal8**+ **SucVal8** compared to **SucVal8**.

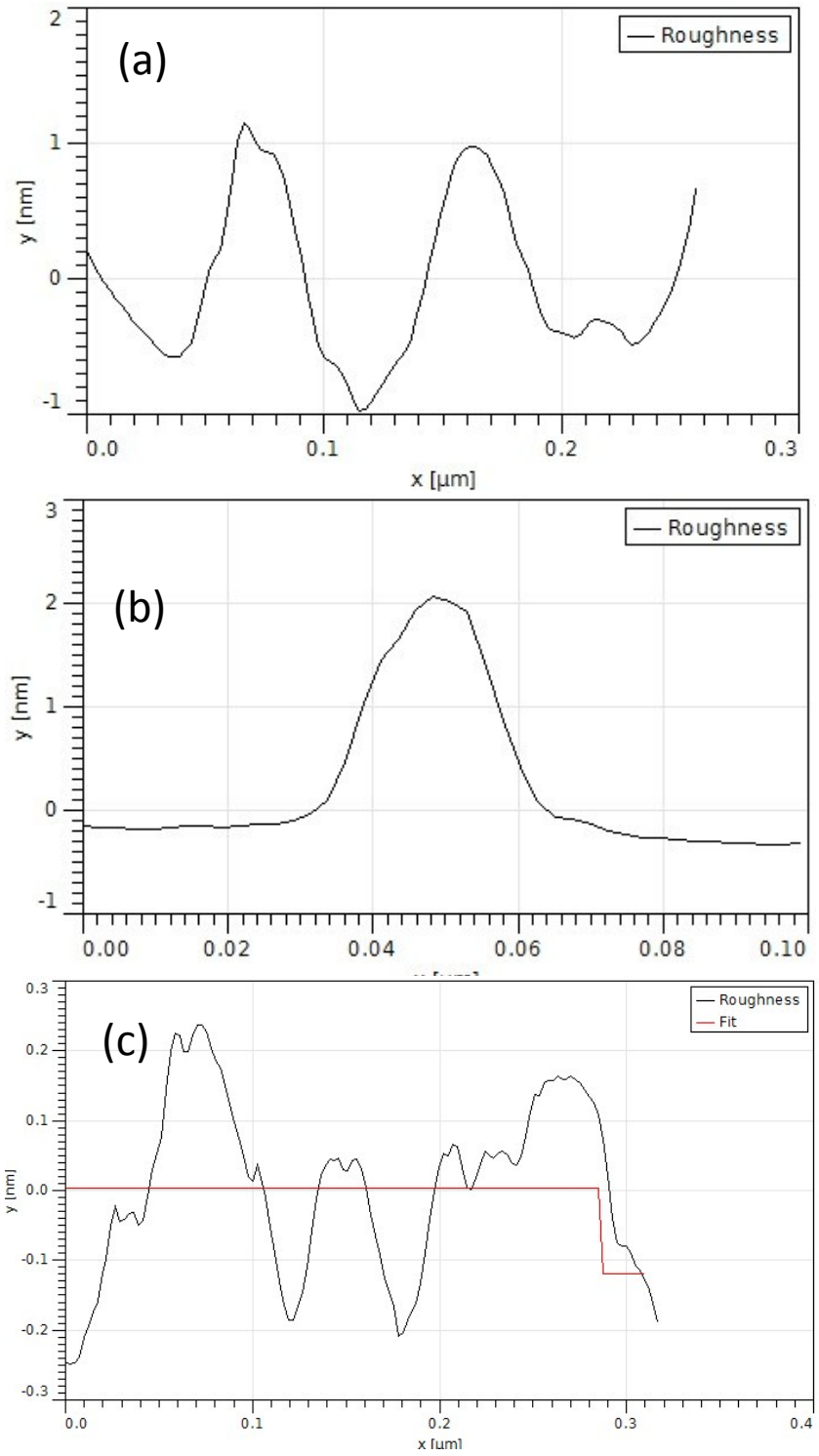


Figure S8: Height and width profile of (a) ProValDoc (Fiber width of 50nm) (b) ProVal8 (Fiber width of around 35nm) (c) SucVal8+ProValDoc (two different widths of 50nm and 10-15nm corresponding to ProValDoc and SucVal8 respectively)

7) Macroscopic aspect:

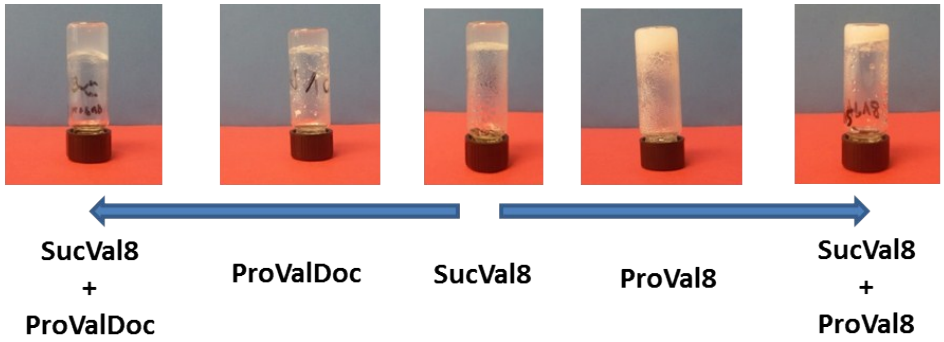


Figure S9. Macroscopic aspect of the different gels at their respective minimum gel concentration (m.g.c.).

8) Rheology:

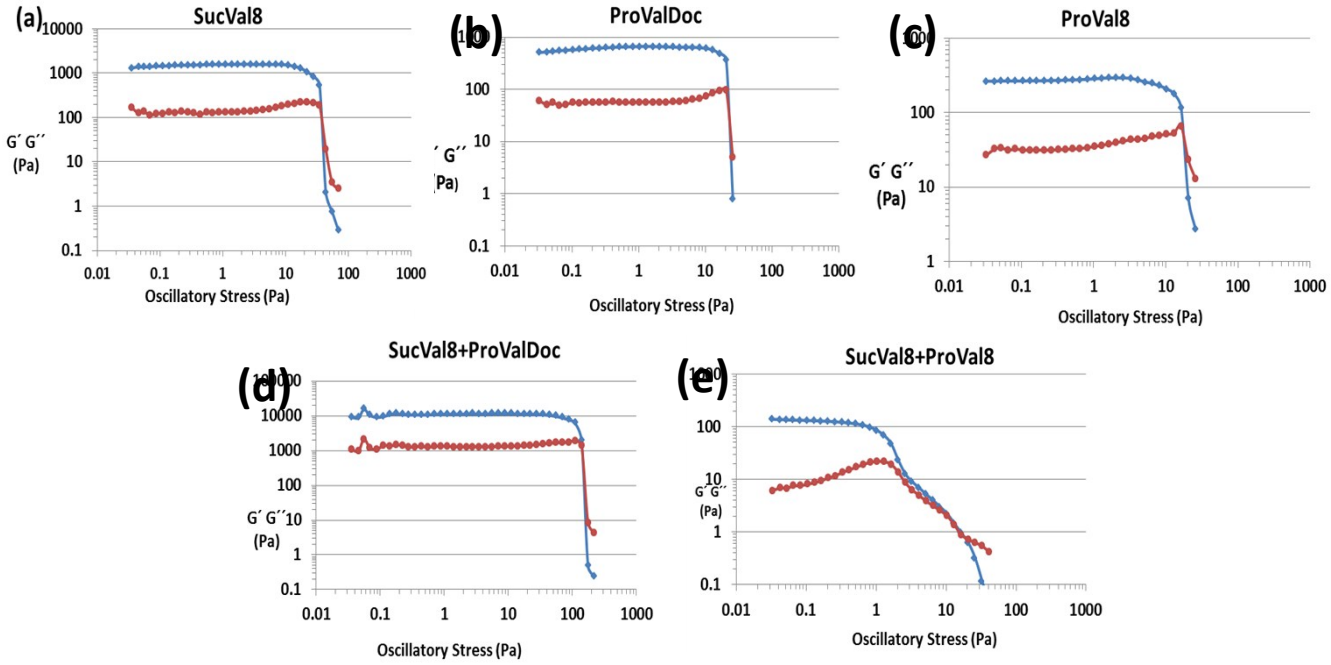


Figure S10: Rheological data for the hydrogels of (a) SucVal8 (b) ProValDoc (c) ProVal8 (d) SucVal8+ProValDoc (e) SucVal8+ProVal8 at their respective MGC.

9) DSC: Measurements were done using a Mettler Toledo 822e differential scanning calorimeter. Heating and cooling rates of 2 °C min^{-1} were employed over a range of 30–150 °C for the xerogels of each sample.

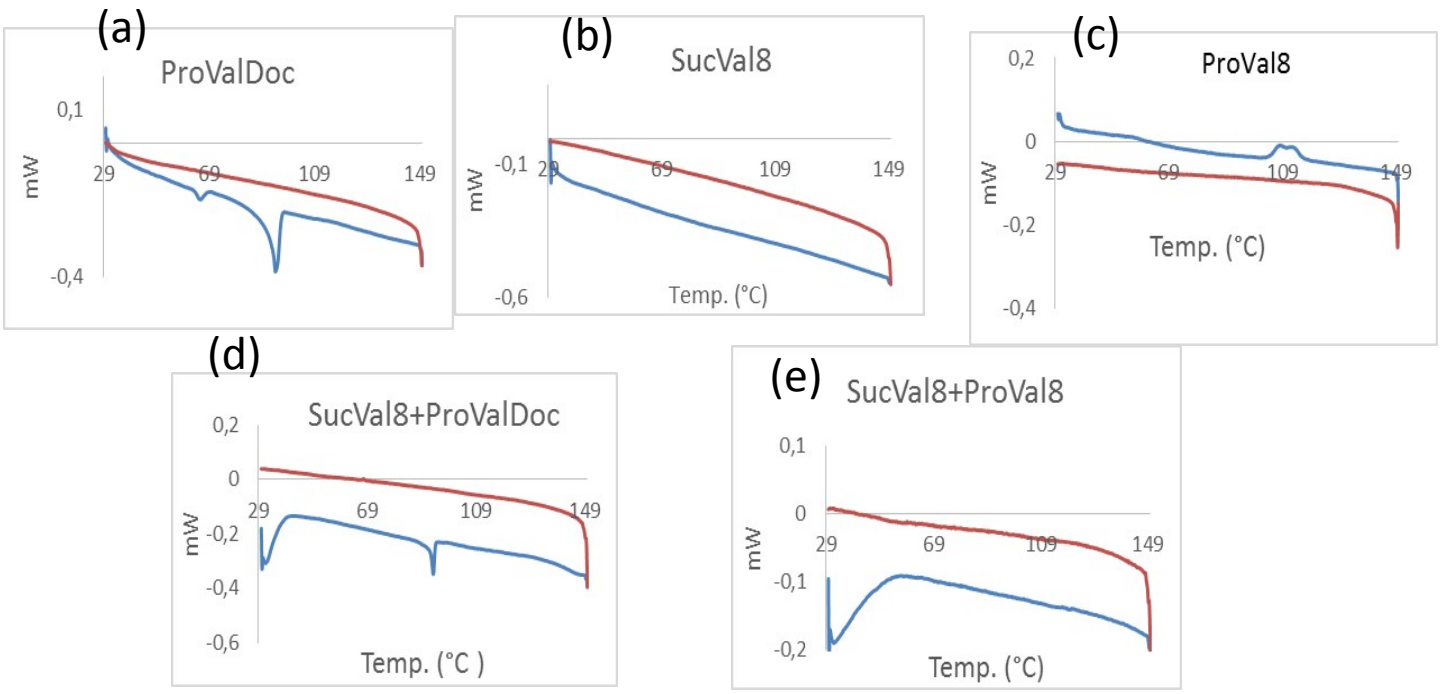


Figure S11: DSC thermograms for the xerogels of (a) ProValDoc (b) SucVal8 (c) ProVal8 (d) SucVal8+ProValDoc (e) SucVal8+ProVal8, Blue lines correspond to the heating cycle and red lines to the cooling cycle.

10) Catalysis:

Different concentrations of benzaldehyde dimethyl acetaland 200µL(10 equivalents or more) of cyclohexanonewere mixed and added simultaneously in the hydrogel and left to react at room temperature. The reaction was extracted twice with 2 mL of $CDCl_3$ and analysed by ^{1}HNMR in order to determine the yield. All the measurements were done in duplicate or triplicate.

Determination of the yield of benzaldehyde: Yield of benzaldehyde was determined by emergence of aldehyde proton of benzaldehyde at (δ: 9.98(s)) and comparing it by decrease in the intensity of the tertiary proton of the acetal (δ:5.43(s)).

Determination of the aldol product: The product of the aldol condensation, 2-(hydroxyphenylmethyl)-cyclohexan-1-one is a known compound and the absolute stereochemistry was determined by comparison with previously reported literature*.(*syn*: 5.39(d)) (*J*=2.4Hz) and (*anti*:4.79(d)) (*J*=8.8Hz)

(*N. Mase et al, *J. Am. Chem. Soc*., **2006**, *128*, 734-735, A. J.A.Cobb et al*, Org. Biomol. Chem,***2005**, *3*, 84-96)

Aldol Condensation by ProVal8:

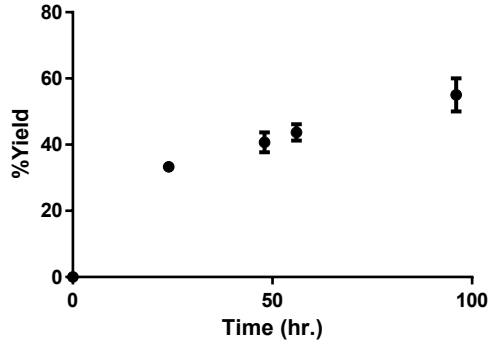


Figure S12: Yield of aldol vs reaction time for the aldol reaction between benzaldehyde and cyclohexanone catalysed by **ProVal8** only.

Tandem Catalysis of the two reactions by the mixture of ProVal8+SucVal8:

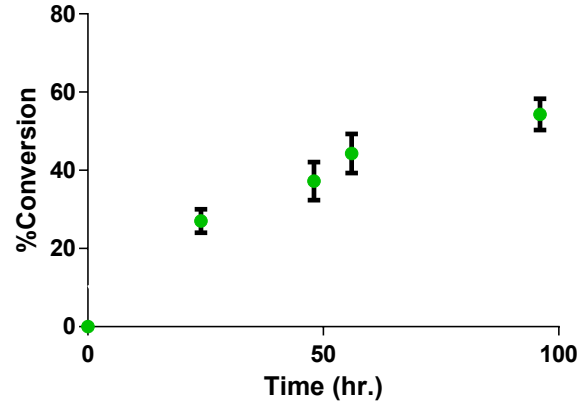
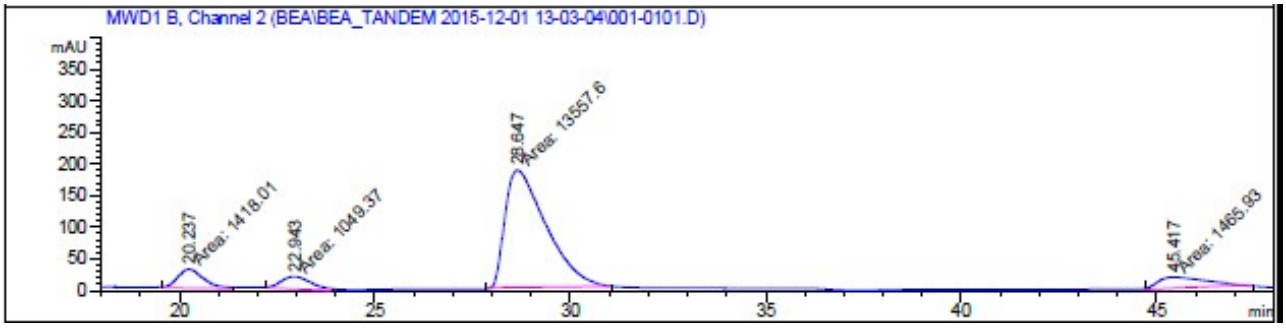


Figure S13: Tandem reaction of acetaldeprotection and aldol condensation carried out in one pot by the mixture of **ProVal8**+**SucVal8** only yielded the product from the first reaction i.e. deprotection of acetal (58% in 96 hours) and no final aldol product.

11) Determination of enantiomeric excess:

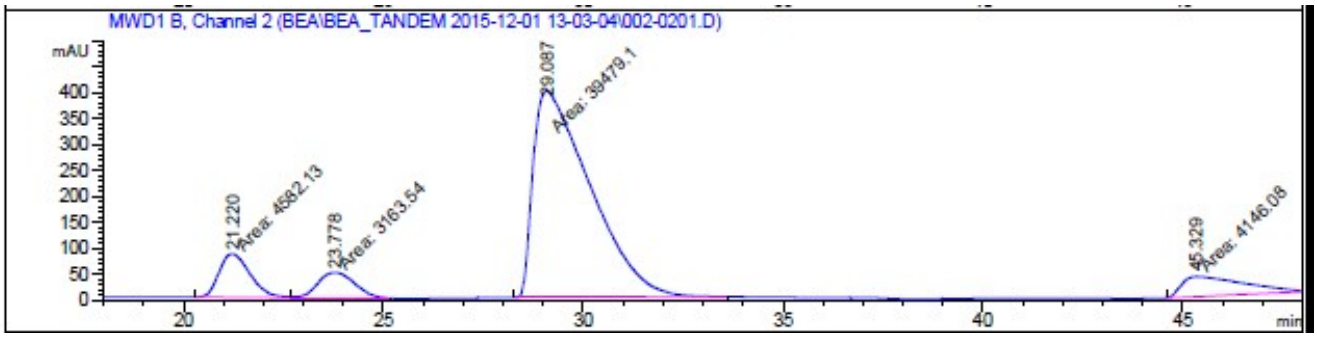
The enantiomeric excess of the aldol adduct was determined by chiral HPLC with a Daicel Chiralcell OD-H column using a previously reported method (S. Rossi et al, Tetrahedron, 67 (2011), 158-166))[eluent:98:2 Hex:IPA; 0.8mL/min flow rate; detection λ=210 nm. t_R=20.3 min (*syn*- minor), t_R=22.9 min (*syn*-major), t_R=28.6 min (*anti*- major). t_R= 45.4 min (*anti*- minor)]

Tandem **SucVal8+ProValdoc:** ee: 90%



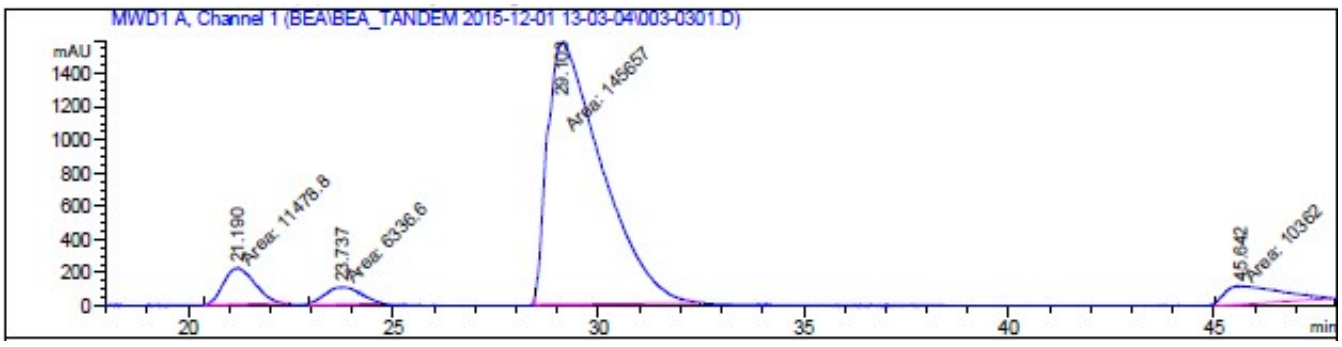
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.237	MM	0.7916	1418.00732	29.85376	8.1071
2	22.943	MM	0.8838	1049.36682	19.78940	5.9995
3	28.647	MM	1.2157	1.35576e4	185.87346	77.5123
4	45.417	MM	1.3715	1465.93176	17.81387	8.3811
Totals :				1.74909e4	253.33049	

Direct Aldol using **Sucval8+Provaldoc** e.e.: 91%



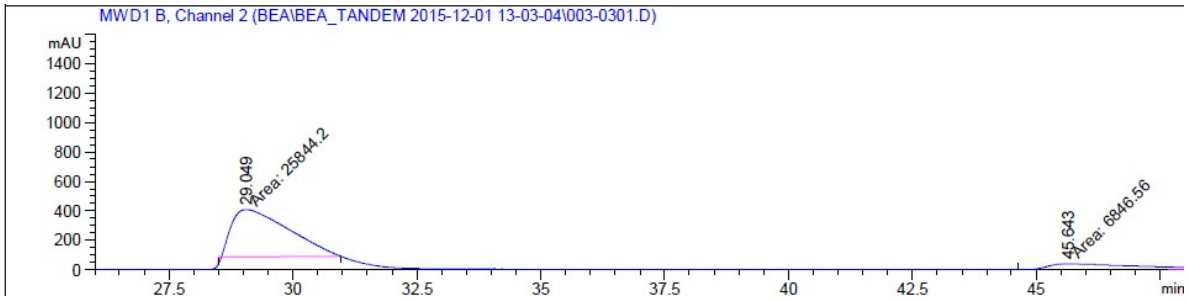
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.220	MM	0.9047	4582.12988	84.41695	8.9197
2	23.778	MM	1.0607	3163.53833	49.70987	6.1582
3	29.087	MM	1.6555	3.94791e4	397.45840	76.8512
4	45.329	MM	1.7839	4146.08398	38.73701	8.0709
Totals :				5.13709e4	570.32224	

Direct Aldol**ProValDoc:** e.e.: 93%



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.190	MM	0.8834	1.14788e4	216.56802	6.6033
2	23.737	MM	1.0162	6336.60352	103.92966	3.6452
3	29.103	MM	1.5430	1.45657e5	1573.25903	83.7907
4	45.642	MM	1.5764	1.03620e4	109.55038	5.9609
Totals :				1.73834e5	2003.30709	

Direct Aldol **ProVal8:** e.e.: 75%



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	4.99e-3	BV	0.0833	9.44242	1.88881	0.0185
2	21.200	MM	1.3253	9606.40039	120.81226	18.7992
3	23.744	MM	1.9497	8793.50195	75.16847	17.2084
4	29.049	MM	1.3334	2.58442e4	323.03012	50.5756
5	45.643	MM	2.2624	6846.56152	50.43694	13.3983

12) FTIR of xerogels.

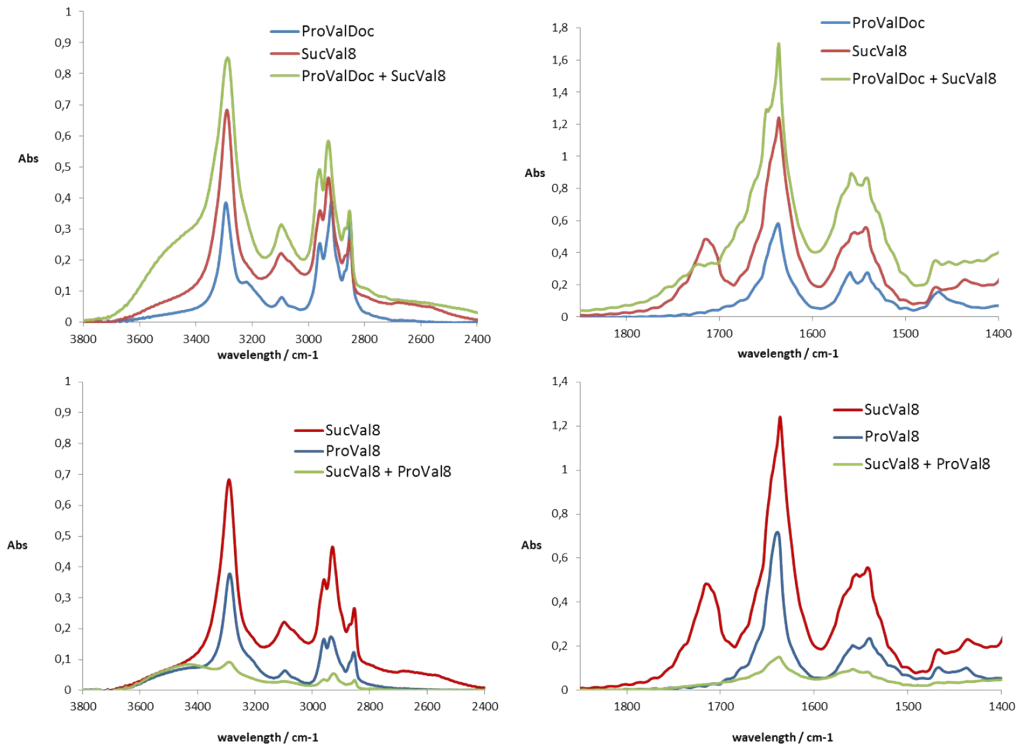


Figure S14: FTIR of freeze-dried xerogels of one-component and mixed samples (KBr pellets).

13) Solubility Experiments:

It is essential to know the amount of molecules present in the solution phase for different gelators, and thus check the catalysis carried out at this concentration to see the difference with catalysis by gel.The amount of molecules present in soluble state can be determined by NMR as molecules in gel are NMR silent. Using an internal standard of known concentration(hydroquinone) at 30°C the amount of molecules in solution was determined. Detailed procedure for previously reported solubility constant of the molecules can be found in the literature.*As reported in the literature, the solubility constant of **ProValDoc** was below 0.2mM which was below the detection limit of 500MHz NMR so experiments were done at 0.1mM. (**SucVal8**: 1.0mM, **ProValDoc**<:0.2mM(experiments were done at 0.1mM for solution state), **ProVal8**: 1.5mM).

*1) F. R. Llansola et. al, *Chem. Commun*., **2009**,7303-7305 2)Escuder et al, *J. Org. Chem*, **2006**, 71, 7747, 3) Hirst et al, *J. Am. Chem. Soc*, **2008**, 130, 9113.

12) Summary of results for the catalysis experiments:

		Separate reactions			Tandem reaction		
Catalyst	**Gel-Sol**	**Deacetalisaiton (Kobs)**	**Aldol (Kobs)**	**ee (Aldol)**	**Deacetalisation(Kobs)**	**Aldol (Kobs)**	**ee (Aldol)**
Proval8	Gel (6mM)	No Product	1.61×10^{-5} $\pm8\times10^{-7}$ s^{-1}	75%	No Product	No Product	
	Sol (1.5mM)	No Product	9.1×10^{-6} $\pm5\times10^{-7}$ s^{-1}		No Product	No Product	

ProValDoc	Gel (5.7mM)	No Product	2.23×10^{-5} $\pm3\times10^{-6}$ s^{-1}	91%	No Product	No Product	
	Sol (0.1mM)	No Product	5.7×10^{-6} $\pm9\times10^{-6}$ s^{-1}		No Product	No Product	
SucVal8	Gel (7mM)	1.5×10^{-4} $\pm3\times10^{-5}$ s^{-1}	No Product		1.2×10^{-4} $\pm4\times10^{-5}$ s^{-1}	No Product	
	Sol (1.0mM)	4.1×10^{-5} $\pm1\times10^{-6}$ s^{-1}	No Product		5.0×10^{-5} $\pm3\times10^{-6}$ s^{-1}	No Product	
Proval8-Sucval8	Gel (6mM-7mM)	8.3×10^{-6} $\pm4\times10^{-7}$ s^{-1}	No Product		8.3×10^{-6} $\pm5\times10^{-7}$ s^{-1}	No Product	
	Sol (1.5mM each)	2.23×10^{-6} $\pm2\times10^{-7}$ s^{-1}	No Product		1.9×10^{-6} $\pm8\times10^{-7}$ s^{-1}	No Product	
Provaldoc-Sucval8	Gel (5.7 Mm-7Mm)	1.4×10^{-4} $\pm4\times10^{-5}$ s^{-1}	$2.2\times10^{-5}\pm3\times10^{-6}$ s^{-1}		1.4×10^{-4} $\pm2\times10^{-5}$ s^{-1}	2.1×10^{-5} $\pm4\times10^{-6}$ s^{-1}	90%
	Sol (0.1mM-1.5mM)	4.1×10^{-5} $\pm3\times10^{-6}$ s^{-1}	No Product		$5\times10^{-5}\pm6\times10^{-6}$ s^{-1}	No Product	

Table S1: Summary of catalysis by different catalysts.