Shaymaa AL SHEHIMY, 25/10/2023

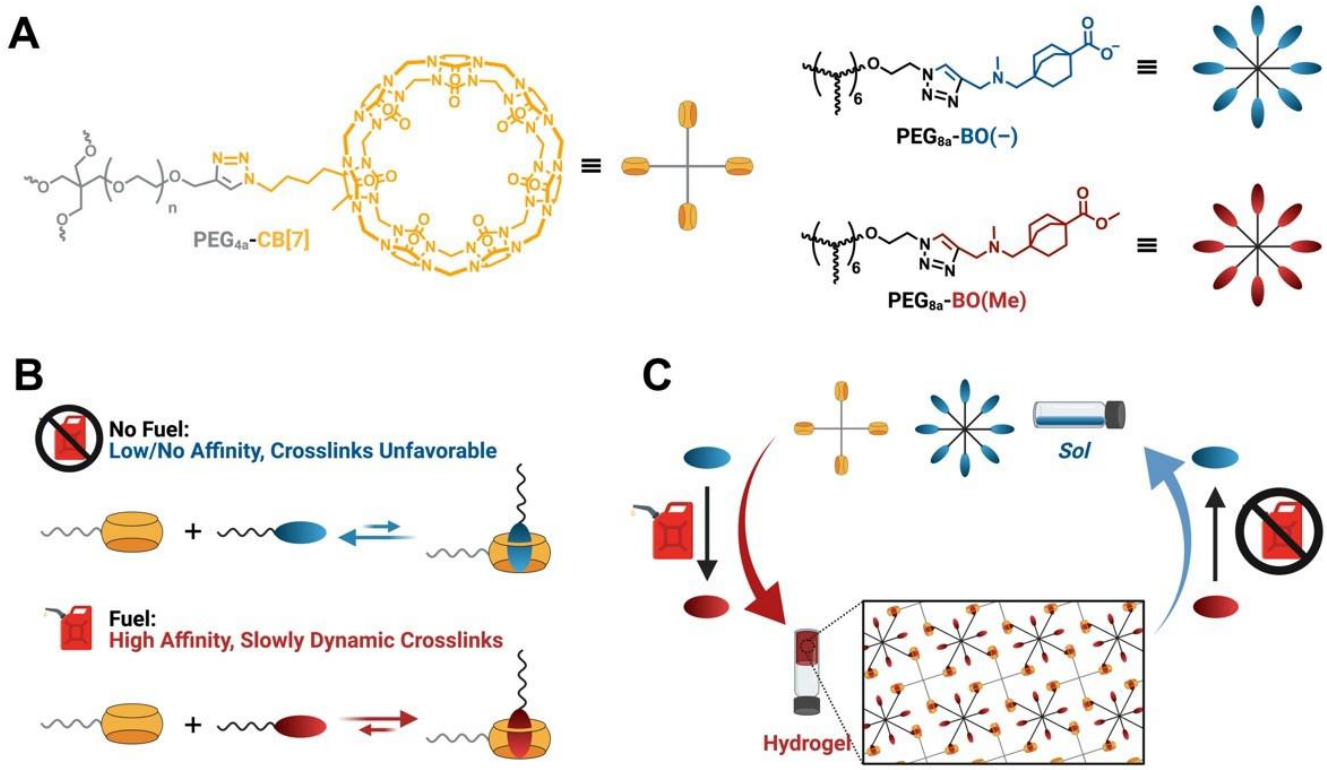
# Transient and Dissipative Host–Guest Hydrogels Regulated by Consumption of a Reactive Chemical Fuel

*Angew. Chem. Int. Ed.* **2023**, *62*, e202216537; doi.org/10.1002/anie.202216537

*Published in January 2023*

*Out-of-equilibrium self-assemblies trigger transient hydrogel formation under basic aqueous conditions*

*Reversible sol-gel transition modulated by pH and quantities of chemical input*




**Who are the corresponding authors and what are their research areas?**

**Matthew Webber**

Professor of Engineering; Associate Professor of Chemical and Biomolecular Engineering at the **College of Engineering, University of Notre Dame.**

Ph.D., Biomedical Engineering, Northwestern University, 2011.

***Research lines of interest:*** Supramolecular Biomaterials and Supramolecular Chemistry, Smart Drug Delivery and Diagnostics, Bio-inspired Materials.

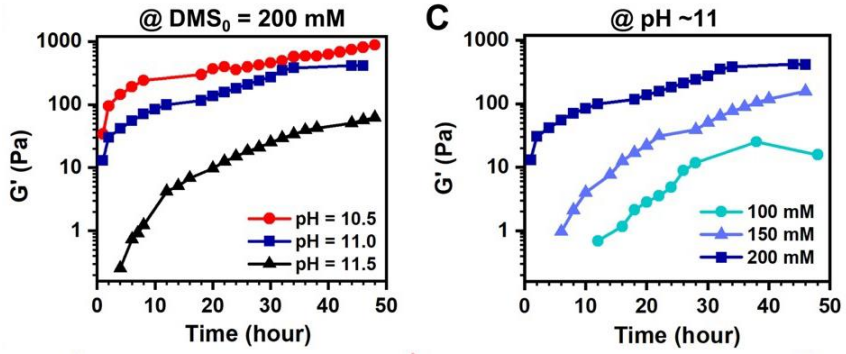
**What is the main claim of the article?**

*In this work, the authors exploit a guest macromer based on bicyclo[2.2.2]octane ($PEG_{8a}$-BO) whose binding affinity to cucurbit[7]uril (CB[7])-based host macromer ($PEG_{4a}$-CB[7]) can be temporarily tuned by chemical modification to give rise to out-of-equilibrium self-assemblies.*

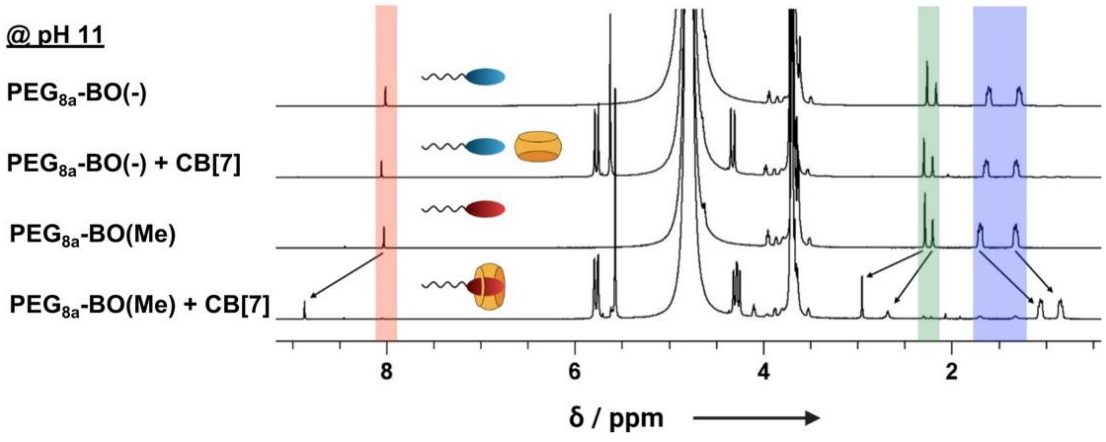
*They show that these host/guest architectures yield a transient hydrogel whose rates of formation and lifetime can be controlled by both pH and quantities of the chemical input.*

**How is it demonstrated?**

*The authors demonstrate the transient hydrogel behavior through oscillatory rheology by fixing one parameter (pH or concentration of chemical input) and varying the other. This helps extract the rate of hydrogel formation, stiffness level, and lifetime at different pH values (pH = 10.5-11.5 ; $[DMS]_0$= 200 mM) or different DMS concentrations ($[DMS]_0$= 100-200 mM ; pH =11).*




*The authors also used NMR to prove that the complexation doesn't take place in the negative form of the guest due to repulsion and only occurs when the acid is protonated (pH = 7) or upon methylation with DMS by following the NMR peaks of the different ($PEG_{8a}$-BO) protons.*



**What are the typical experimental conditions?**

*Host Guest mixture 5wt% of $PEG_{8a}$-BO(–) and $PEG_{4a}$-CB[7] in 0.5 M sodium borate buffer.*

*pH was regulated with HCl to reach pH= 7 or NaOH to increase back to 11.*

*Chemical input DMS: dimethyl sulfate (100-200 mM)*

**Which are the key related papers?**

P. C. Cai, B. Su, L. Zou, M. J. Webber, S. C. Heilshorn, A. J. Spakowitz, **Rheological Characterization and Theoretical Modeling Establish Molecular Design Rules for Tailored Dynamically Associating Polymers**, *ACS Cent. Sci.* **2022**, *8*, 1318–1327. *Directs the choice of the tunable chemical moiety which controls the host/guest affinity upon chemical modification or pH variation.*

*J. Boekhoven, W. E. Hendriksen, G. J. M. Koper, R. Eelkema, J. H. van Esch,* ***Transient assembly of active materials fueled by a chemical reaction****, Science* ***2015****, 349, 1075–1079. The use of DMS as a chemical input to induce the formation of transient assemblies.*

*B. Rieß, R. K. Grötsch, J. Boekhoven,* ***The Design of Dissipative Molecular Assemblies Driven by Chemical Reaction Cycles,*** *Chem* ***2020****, 6, 552–578. Recent example of a supramolecular hydrogel-forming fibers formed upon continuous consumption of a chemical input.*

**Additional comments, including additional elements of interest**

*The cyclability of the system by employing conditions that give rise to hydrogel formation and subsequent hydrolysis within reasonable time scales shows that it is limited to three cycles by waste accumulation.*

*The residual ester species can account for the reduced time required to form the gel in the second and third cycles compared to the third one.*

*HPLC studies have shown how rates of ester formation and ester hydrolysis are modified between small molecules and the macromer. The more accelerated rate in the formation wasn't thoroughly discussed, but the delayed hydrolysis in the hydrogel is explained by the shielding of the ester by the CB[7].*

*HPLC also used to confirm the absence of other methylated side-products on the azide or tertiary amine.*