How to cite: *Angew. Chem. Int. Ed.* **2024**, e202419575
doi.org/10.1002/anie.202419575

Photoswitchable Catalysis *Hot Paper*

Light-Responsive Aldehyde-Reduction Catalysis Through Catalyst Encapsulation

*Amit Ghosh, John D. Thoburn, and Jonathan R. Nitschke**

Abstract: We report a light-responsive tetrahedral metal–organic capsule that binds a perrhenate catalyst, which is released selectively upon irradiation with 350 nm light, turning on the catalytic reduction of organic carbonyls by hydrosilanes. The catalytic activity can be switched off by heating at 75 °C for 2.5 h, which stimulates capsule reformation and catalyst re-encapsulation. Multiple on-off cycles were shown, with a clear relationship between product yield and light irradiation time. Encapsulation thus enables the coupling of light-responsiveness to catalysis in a manner that might be generalized to other catalysts and capsules.

Metal–organic capsules[1] have shown promise in catalysis due to their well-defined structures,[2] tunable chemical environments,[3] and the confined reaction environments that they provide.[4] The integration of photoresponsive elements into metal–organic capsules has the potential to enable dynamic modulation of catalytic activity through light.[5]

The use of light as a stimulus increases the utility of catalysis, offering advantages that include precise spatial and temporal control, non-invasiveness, and tunability of wavelength and intensity.[6] The exploration of photoresponsive materials for catalysis has been driven by the prospect of achieving switchable catalytic processes with unprecedented levels of control.[7] Key examples include the utilization of azobenzene-functionalized metal–organic frameworks[8] and supramolecular assemblies[9] with light-responsive gates for achieving stimuli-responsive catalysis. These studies have demonstrated the potential of photoresponsive materials to modulate catalytic activity in a controlled manner, opening new avenues for applications in synthesis.

Building upon these advances, this work presents an approach to switchable catalysis using photoresponsive metal–organic capsules. Our tetrahedral metal–organic capsule, functionalized with light-responsive diazo moieties at its metal-ion vertices,[10] reversibly captures and releases the active catalyst perrhenate, governing its catalytic activity in organic transformations.

Perrhenate is known to act as a catalyst for various chemical reactions, including the epoxidation of alkenes,[11] the Beckmann rearrangement of oximes,[12] and deoxydehydration of glycols.[13] However, these processes often require harsh conditions, involving hydrogen peroxide, strong acids, or temperatures exceeding 150 °C. As these conditions would destroy most metal–organic cages, we sought reactions that would proceed under milder conditions to probe cage-mediated perrhenate catalysis. Recent studies have shown that ReO_4^- can serve as a catalyst for the reduction of organic carbonyls by hydrosilanes under much milder conditions.[14] Here we introduce the use of coordination cage **1** (Figure 1a) as a synthetic host that binds perrhenate

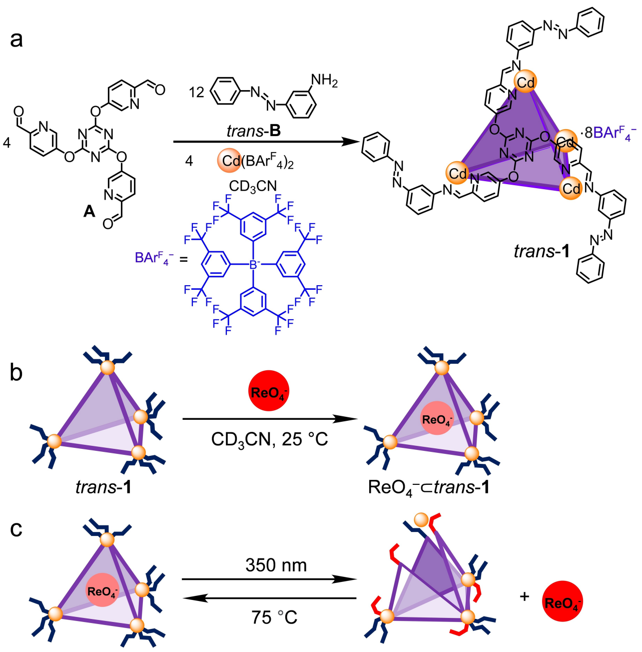
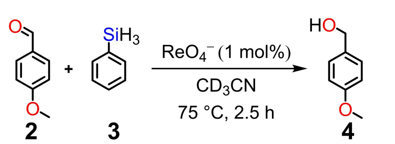


Figure 1. Guest binding and release by photo-responsive cage *trans*-**1**. (a) The assembly of subcomponents **A** and *trans*-**B** with Cd^{II} produced cage *trans*-**1**, (b) which binds the anionic guest perrhenate; only one of the four ligands forming the faces of the tetrahedron is shown. (c) Reversible perrhenate release and uptake from *trans*-**1** are driven by light and heat, respectively.

[*] Dr. A. Ghosh, Prof. J. R. Nitschke
Yusuf Hamied Department of Chemistry
University of Cambridge
Cambridge CB2 1EW, United Kingdom
E-mail: jrn34@cam.ac.uk

Dr. J. D. Thoburn
Department of Chemistry
Randolph Macon College
Ashland 23005, USA

a



b

Catalyst	Yield / %
ReO_4^-	89 (±3)
ReO_4^-⊂*trans*-**1**	3 (±1)
Released ReO_4^- after 30 minutes of irradiation	23 (±2)

c

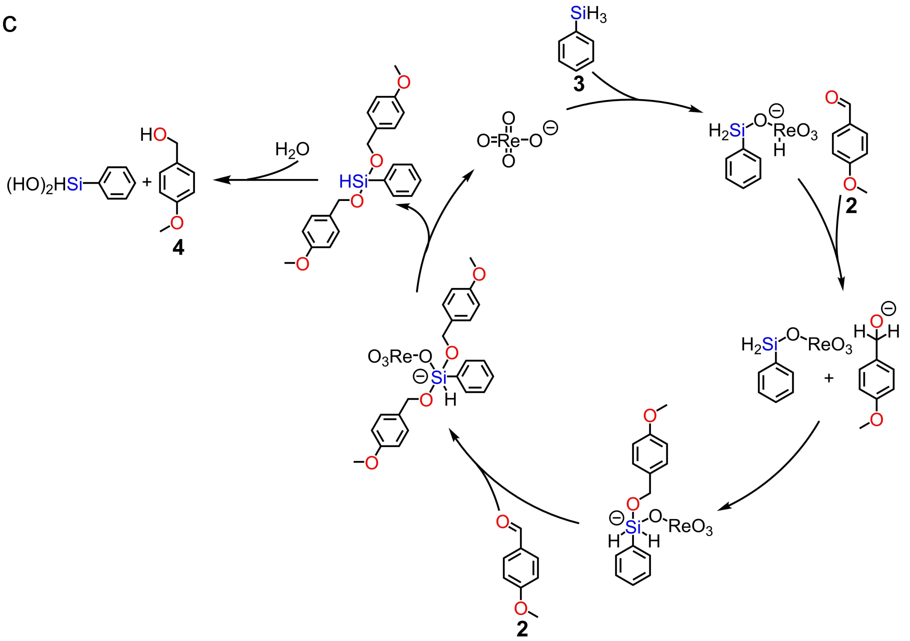


Figure 2. Binding of perrhenate within **1** deactivates its catalytic activity, whereas its photo-stimulated release reactivates catalysis. (a) General reaction scheme for the synthesis of product **4** under perrhenate catalysis. (b) Yield of anisyl alcohol observed under the conditions noted. (c) Catalytic cycle for the formation of **4** from **2** and **3**, catalyzed by ReO_4^-.

ions, which can act as a catalyst for the reduction of aldehydes.

When exposed to light as depicted in Figure 1c, the 12 diazo moieties within **1** undergo isomerization from the *trans* to the *cis* configuration, leading to steric clashes and subsequent dissociation of the cage vertices, ultimately leading to the release of the bound perrhenate ion. This released perrhenate can subsequently catalyze the reduction of *p*-anisaldehyde. Heating at 75 °C subsequently converted the *cis* diazo moieties back to the *trans* configuration, regenerating the cage, triggering reuptake of the perrhenate catalyst, and preventing further reaction. This cycle can be repeated until the substrates are consumed, presenting an attractive method for switchable catalysis and emphasizing the potential for controlling a reaction using light.

Building upon prior work involving light-driven guest uptake and release,[15] we designed cage **1**.[10] Tritopic formylpyridine subcomponent **A**[10b] (4 equiv) and *trans*-**B** (12 equiv) reacted with cadmium(II) bis(tetrakis(3,5-bis(trifluoromethyl)phenyl)borate $Cd(BAr^F{}_4)_2$, 4 equiv) in acetonitrile, yielding the tetrahedral capsule *trans*-**1** (Figure 1a) as the uniquely-observed product. Non-coordinating $BAr^F{}_4{}^-$ was chosen as the counter-anion for **1** because $BAr^F{}_4{}^-$ is larger (968 Å^3)[16] than the cavity volume of **1** (180 Å^3), eliminating the possibility of competition with ReO_4^-. Characterization of *trans*-**1** was undertaken by NMR spectroscopy (Figures S2–S7), electrospray ionization mass spectrometry (ESI-MS) (Figures S8 and S9) and UV/Vis spectroscopy (Figure S10). In the presence of visible light, all the azo groups remain in their *trans* form. Analysis of the ^{1}H NMR spectra of **1** indicated the presence of only one set of ligand signals, suggesting the exclusive formation of a *T*-symmetrical product *trans*-**1** (Figure S2). Examination of the ^{1}H DOSY spectrum confirmed the existence of a single species, with a diffusion coefficient (D) of $4.2\times10^{-10}\,m^2s^{-1}$ (Figure S5), corresponding to a hydrodynamic radius of 15.3 Å, consistent with our proposed tetrahedral structure.

Upon exposure to 350 nm light, the *trans*-azobenzene moieties situated at the vertices of cage **1** underwent photoisomerization, resulting in the formation of the *cis* configuration. This process was monitored through ^{1}H NMR (Figures S12–S13) and UV/Vis spectroscopy (Figure S15). The ^{1}H NMR spectra revealed multiple sets of ligand signals, indicating the presence of a mixture of cages containing both *cis*- and *trans*-diazo moieties (Figure S12). Photoswitching induced steric clashes among *cis*-diazo groups, partially disassembling the cage, as previously reported.[10b] Subsequently, heating at 75 °C reversed this partial disassembly, restoring cage *trans*-**1**, as confirmed by ^{1}H NMR (Figures S13 and S14).

We investigated the ability of *trans*-**1** to bind perrhenate (Figure 1b). Addition of tetrabutylammonium perrhenate to a solution of *trans*-**1** resulted in significant shifts of NMR peaks, consistent with guest binding (Figure S17). ReO_4^-⊂-

trans-**1** exhibited downfield shifts of inward-facing proton signals (Figure S18), consistent with close contacts between encapsulated ReO_4^- and the aromatic panels lining the cage cavity. NMR titration provided a binding constant $K_a = 7.6\times10^2\ M^{-1}$ (Figure S25). The volume of the perrhenate anion (70 Å^3) occupies 39 % of the cavity volume of **1** (180 Å^3), consistent with Rebek's 55 % rule.[17] We infer binding to be driven by the coulombic interactions between the anionic guest and the cationic cage framework. Additionally, ^{19}F NMR data (Figure S28) confirm guest binding within a Zn^{II} analog of cage **1**,[10b] showing displacement of the already-bound guest by ReO_4^-, consistent with a direct guest exchange process.

The isomerization of the diazo moieties of **1** provided control over the release and uptake of ReO_4^- using light and heat as external stimuli (Figure 1c). When $ReO_4^-\subset$*trans*-**1** was irradiated with 350 nm light, photoisomerization promoted the dissociation of the cage, as evidenced by ^{1}H NMR spectra (Figure S32), releasing the ReO_4^-. Conversely, upon heating at 75 °C, cage *trans*-**1** reformed, resulting in the re-uptake of ReO_4^-, as confirmed by ^{1}H NMR (Figure S33) and UV/Vis spectroscopy (Figure S35).

After establishing reversible guest release and uptake, we evaluated the efficiency of the system as a photo-switchable catalyst, whereby released ReO_4^- is expected to catalyze the reduction of *p*-anisaldehyde by phenylsilane, yielding anisyl alcohol. Catalytic activity was not anticipated for the $ReO_4^-\subset$*trans*-**1** complex, as encapsulated ReO_4^- ions were hypothesized to remain unreactive. Cage **1** was chosen because it was not observed to bind neutral substrates,[10b] ensuring that only suitably-sized anionic guests, such as ReO_4^-, would be selectively encapsulated.

An NMR-scale trial reaction was carried out between substrate **2** and $PhSiH_3$ (1.2 equiv) in the presence of 1 mol % of tetrabutylammonium perrhenate. After 2.5 h at 75 °C, the ^{1}H NMR spectrum indicated near-complete consumption of the aldehyde and formation of product **4** (Figure S39).

A possible pathway for the reaction of **2** with phenylsilane (**3**) and the perrhenate catalyst is shown in Figure 2c. Phenylsilane and perrhenate react to form a five-coordinate silicon center, where the aldehyde reacts directly with the Si–H bond to yield the intermediate shown. This intermediate then reacts with another molecule of **2**, followed by hydrolysis to form the final product **4**.

We then carried out the same reaction in the presence of cage **1** both before and after illumination (Figure 2). As shown in Figure 2, when a 1:1.2 mixture of **2** and **3** was heated at 75 °C in the presence of the closed complex $ReO_4^-\subset$*trans*-**1** (1 mol %), only traces of anisyl alcohol **4** were observed (Figure 2b and Figure S42). Under otherwise-identical conditions, but after exposure to 350 nm light, 23 % of product **4** was obtained (Figure 2b). Further heating to 75 °C for 2.5 h yield only 2 % additional product, as this temperature stimulated the reformation of *trans*-**1**, leading to the reuptake of ReO_4^-. Upon irradiation with 350 nm light, the cage partially disassembled, releasing the catalytic guest while retaining its structural integrity, with Cd^{2+} coordination preserving the stability of the pyridyl aldehyde moieties under reducing conditions.

Investigations were then carried out as to the effects of photo-switching the catalytic formation of **4** on and off multiple times before the reaction had reached completion (Figure 3b). A 1:1.2 mixture of **2** and **3** in the presence of 1 mol % $ReO_4^-\subset$*trans*-**1** yielded 3 % of product **4** after heating at 75 °C for 2.5 h (Figure S47i). Subsequent illumination at 350 nm resulted in an overall yield of 27 % of product **4** after 2.5 h (Figure S47iii). The heating period again facilitated product formation, but also resulted in the recapture of ReO_4^-, regenerating $ReO_4^-\subset$*trans*-**1**. This competing process resulted in the lower yield observed in this state, as compared to reactions conducted without **1** (Figure S39). Further heating under the same conditions for 2.5 h resulted in an increase of the total yield to 29 % (Figure S47iv). A second cycle of irradiation and heating resulted in a cumulative yield of 39 % (Figure S47vi), with a third cycle increasing the total yield to 45 % (Figure S47ix). The decrease in yield between the first and second illumination cycles (Figure 3b) is attributed to the depletion of reactants and hydrolysis of phenylsilane, which reduced the amount of product generated in subsequent cycles.

Finally, we investigated whether catalysis could be modulated by varying the duration of illumination (Figure 3c). To better understand the structural changes occurring during this process, we monitored the photoisomerization of $ReO_4^-\subset$*trans*-**1** at different illumination times (Figure S48). Then, the reaction was conducted using $ReO_4^-\subset$*trans*-**1** after light exposure from 5 to 30 minutes, with dark intervals of 5 minutes between them (Figure S50). The results showed a linear correlation between the degree of cage disassembly and product yield (Figure 3c). As the duration of irradiation increased, more cages opened, releasing more ReO_4^- and consequently resulting in higher yields of product.

In conclusion, this study demonstrates the potential of light-responsive metal–organic capsules in switchable catalysis, showing how they can regulate free catalyst concentration, and thus reaction rate, through reversible structural changes involving guest release and uptake triggered by light exposure. Our findings may enable switchable catalysis in novel contexts, by coupling light exposure together with catalytic activity. Future development of this concept may enable the development of new switchable materials and reactions, and the design of complex chemical systems[18] where competing rates of catalytic reactions may be governed by light-mediated encapsulation. Additionally, future work will aim to optimize this photo-switchable catalyst system by enhancing its efficiency and expanding its applicability to other catalytic processes.

Supporting Information

Full experimental procedures can be found in the Supporting Information. The authors have cited additional references within the Supporting Information.[19,24]

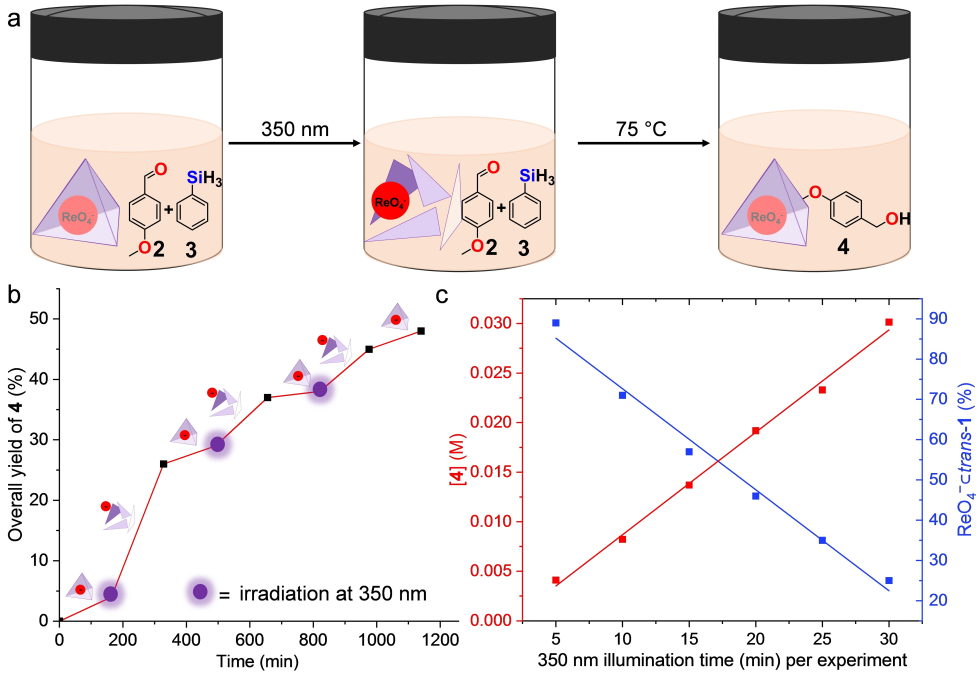


Figure 3. Photo-switching of the catalytic reduction of *p*-anisaldehyde by ReO_4^- mediated by *trans*-**1**. (a) Catalyst release from **1** triggered the reaction between **2** and **3**. (b) The yield of **4** was observed to increase after each pulse of light applied to the system as ReO_4^- was released. (c) Correlation between the quantity of product **4** formed and the release of ReO_4^- from **1** under varying 350 nm illumination times.

Acknowledgements

This work was supported by the UK Engineering and Physical Sciences Research Council (EPSRC) (EP/T031603/1) and the European Research Council (ERC 695009). The authors thank the Department of Chemistry NMR facility at the University of Cambridge for performing some NMR experiments. A.G. acknowledges the Deutsche Forschungsgemeinschaft for a Walter Benjamin postdoctoral fellowship.

Conflict of Interest

The authors declare no competing interests.

Data Availability Statement

All data supporting the findings of this study are included within the article and its Supplemental Information, and are also available from the authors upon request.

Keywords: Supramolecular chemistry · switchable catalysis · photo-switchable cages · coordination capsules · subcomponent self-assembly

[1] a) S. Leininger, B. Olenyuk, P. J. Stang, *Chem. Rev.* **2000**, *100*, 853–907; b) D. Fujita, Y. Ueda, S. Sato, N. Mizuno, T. Kumasaka, M. Fujita, *Nature* **2016**, *540*, 563–566; c) M. Pan, K. Wu, J. H. Zhang, C. Y. Su, *Coord. Chem. Rev.* **2019**, *378*, 333–349; d) W. M. Bloch, Y. Abe, J. J. Holstein, C. M. Wandtke, B. Dittrich, G. H. Clever, *J. Am. Chem. Soc.* **2016**, *138*, 13750–13755; e) X. Zhang, X. Dong, W. Lu, D. Luo, X.-W. Zhu, X. Li, X.-P. Zhou, D. Li, *J. Am. Chem. Soc.* **2019**, *141*, 11621–11627; f) D. Zhang, T. K. Ronson, J. L. Greenfield, T. Brotin, P. Berthault, E. Léonce, J.-L. Zhu, L. Xu, J. R. Nitschke, *J. Am. Chem. Soc.* **2019**, *141*, 8339–8345; g) J. Roukala, J. Zhu, C. Giri, K. Rissanen, P. Lantto, V.-V. Telkki, *J. Am. Chem. Soc.* **2015**, *137*, 2464–2467; h) D. Zhang, T. K. Ronson, Y–Q. Zou, J. R. Nitschke, *Nat. Chem. Rev.* **2021**, *5*, 168–182; i) C. García-Simón, R. Gramage-Doria, S. Raoufmoghaddam, T. Parella, M. Costas, X. Ribas, J. N. H. Reek, *J. Am. Chem. Soc.* **2015**, *137*, 2680–2687; j) V. Iannace, C. Sabrià, Y. Xu, M. von Delius, I. Imaz, D. Maspoch, F. Feixas, X. Ribas, *J. Am. Chem. Soc.* **2024**, *146*, 5186–5194.

[2] a) T. K. Piskorz, V. Mart-Centelles, R. L. Spoicer, F. Duarte, P. J. Lusby, *Chem. Sci.* **2023**, *14*, 11300–11331; b) S. Chen, L.-J. Chen, *Chemistry* **2022**, *4*, 494–519; c) R. Saha, B. Mondal, P. S. Mukherjee, *Chem. Rev.* **2022**, *122*, 12244–12307; d) S. Pullen, J. Tessarolo, G. H. Clever, *Chem. Sci.* **2021**, *12*, 7269–7293; e) Y. Fang, J. A. Powell, E. Li, Q. Wang, Z. Perry, A. Kirchon, X. Yang, Z. Xiao, C. Zhu, L. Zhang, F. Huang, H. C. Zhou, *Chem. Soc. Rev.* **2019**, *48*, 4707–4730.

[3] a) J. E. M. Lewis, *Trends Chem.* **2023**, *5*, 717–719; b) C. J. Brown, F. D. Toste, R. G. Bergman, K. N. Raymond, *Chem. Rev.* **2015**, *115*, 3012–3035.

[4] a) Y. Xue, X. Hang, J. Ding, B. Li, R. Zhu, H. Pang, Q. Xu, *Coord. Chem. Rev.* **2021**, *430*, 213656; b) F.-F. Zhu, L.-J. Chen, S. Chen, G.-Y. Wu, W.-L. Jiang, J.-C. Shen, Y. Qin, L. Xu, H.-B. Yang, *Chem* **2020**, *6*, 2395–2406; c) M. Morimoto, S. M. Bierschenk, K. T. Xia, R. G. Bergman, K. N. Raymond, F. D. Toste, *Nat. Catal.* **2020**, *3*, 969–984.

[5] a) R. G. DiNardi, S. Rasheed, S. S. Capomolla, M. H. Chak, I. A. Middleton, L. K. Macreadie, J. P. Violi, W. A. Donald, P. J. Lusby, J. E. Beves, *J. Am. Chem. Soc.* **2024**, *146*, 21196–21202; b) E. Nieland, J. Voss, B. M. Schmidt, *ChemPlusChem*

2023, *88*, e202300353; c) R. G. DiNardi, A. O. Douglas, R. Tian, J. R. Price, M. Tajik, W. A. Donald, J. E. Beves, *Angew. Chem. Int. Ed.* **2022**, *61*, e202205701; d) S. J. Wezenberg, *Chem. Lett.* **2020**, *49*, 609–615.
[6] a) R. Liu, X. Zhang, F. Xia, Y. Dai, *J. Catal.* **2022**, *409*, 33–40; b) Z. Freixa, *Catal. Sci. Technol.* **2020**, *10*, 3122–3139; c) R. Dorel, B. L. Feringa, *Chem. Commun.* **2019**, *55*, 6477–6486; d) B. M. Neilson, C. W. Bielawski, *ACS Catal.* **2013**, *3*, 1874–1885.
[7] a) M. Kravets, M. Flaibani, M. Szewczyk, P. Posocco, V. Sashuk, *ACS Catal.* **2023**, *13*, 15967–15976; b) G. C. Thaggard, J. Haimerl, R. A. Fischer, K. C. Park, N. B. Shustova, *Angew. Chem. Int. Ed.* **2023**, *62*, e202302859; c) Z. Li, Y. Shi, A. Zhu, Y. Zhao, H. Wang, B. P. Binks, J. Wang, *Angew. Chem. Int. Ed.* **2021**, *60*, 3928–3933; d) H. Zhao, S. Sen, T. Udayabhaskararao, M. Sawczyk, K. Kučanda, D. Manna, P. K. Kundu, J.-W. Lee, P. Král, R. Klajn, *Nat. Nanotechnol.* **2016**, *11*, 82–88; e) D. Wilson, N. R. Branda, *Angew. Chem. Int. Ed.* **2012**, *51*, 5431–5434; f) J. Wang, B. L. Feringa, *Science* **2011**, *331*, 1429–1432; g) D. Sud, T. B. Norsten, N. R. Branda, *Angew. Chem. Int. Ed.* **2005**, *44*, 2019–2021.
[8] H. Wen, W.-J. Zhang, Z.-J. Diao, W. Liu, G. Liu, C. Gu, T. Yang, H.-O. Qi, L.-B. Sun, *Inorg. Chem.* **2023**, *62*, 8655–8662.
[9] a) C. Z.-J. Ren, P. S. Muñana, J. Dupont, S. S. Zhou, J. L.-Y. Chen, *Angew. Chem. Int. Ed.* **2019**, *58*, 15254–15258; b) Y. Zhao, B. Lei, M. Wang, S. Wu, W. Qi, R. Suabc, Z. He, *J. Mater. Chem. B* **2018**, *6*, 2444–2449; c) M. Samanta, V. S. Rama Krishna, S. Bandyopadhyay, *Chem. Commun.* **2014**, *50*, 10577–10579; d) T. Imahori, R. Yamaguchi, S. Kurihara, *Chem. Eur. J.* **2012**, *18*, 10802–10807; e) R. Cacciapaglia, S. Di Stefano, L. Mandolini, *J. Am. Chem. Soc.* **2003**, *125*, 2224–2227; f) W.-S. Lee, A. Ueno, *Macromol. Rapid Commun.* **2001**, *22*, 448–450; g) F. Würthner, J. Rebek, *Angew. Chem. Int. Ed. Engl.* **1995**, *34*, 446–448.
[10] a) A. Ghosh, J. Pruchyathamkorn, C. F. Espinosa, J. R. Nitschke, *J. Am. Chem. Soc.* **2024**, *146*, 2568–2573; b) A. Ghosh, L. Slappendel, B.-N. T. Nguyen, L. K. S. von Krbek, T. K. Ronson, A. M. Castilla, J. R. Nitschke, *J. Am. Chem. Soc.* **2023**, *145*, 3828–3832.
[11] a) M. Cokoja, R. M. Reich, F. E. Kühn, *Catal. Commun.* **2017**, *100*, 103–106; b) M. Cokoja, I. I. E. Markovits, M. H. Anthofer, S. Poplata, A. Pöthig, D. S. Morris, P. A. Tasker, W. A. Herrmann, F. E. Kühn, J. B. Love, *Chem. Commun.* **2015**, *51*, 3399–3402.
[12] K. Narasaka, H. Kusama, Y. Yamashita, H. Sato, *Chem. Lett.* **1993**, *22*, 489–492.
[13] a) A. L. Denning, H. Dang, Z. Liu, K. M. Nicholas, F. C. Jentoft, *ChemCatChem* **2013**, *5*, 3567–3570; b) C. Boucher-Jacobs, K. M. Nicholas, *ChemSusChem* **2013**, *6*, 597–599.
[14] D. S. Morris, C. Weetman, J. T. C. Wennmacher, M. Cokoja, M. Drees, F. E. Kühn, J. B. Love, *Catal. Sci. Technol.* **2017**, *7*, 2838–2845.
[15] a) H. Lee, J. Tessarolo, D. Langbehn, A. Baksi, R. Herges, G. H. Clever, *J. Am. Chem. Soc.* **2022**, *144*, 3099–3105; b) M. Han, R. Michel, B. He, Y. S. Chen, D. Stalke, M. John, G. H. Clever, *Angew. Chem. Int. Ed.* **2013**, *52*, 1319–1323; c) T. Murase, S. Sato, M. Fujita, *Angew. Chem. Int. Ed.* **2007**, *46*, 5133–5136.
[16] J. Cullinane, A. Jolleys, F. S. Mair, *Dalton Trans.* **2013**, *42*, 11971–11975.
[17] S. Mecozzi, J. Rebek Jr., *Chem. Eur. J.* **1998**, *4*, 1016–1022.
[18] J. S. Valera, Á. López-Acosta, T. M. Hermans, *Angew. Chem. Int. Ed.* **2024**, *63*, e202406931.
[19] J. Vapaavuori, A. Goulet-Hanssens, I. T. S. Heikkinen, C. J. Barrett, A. Priimagi, *Chem. Mater.* **2014**, *26*, 5089–5096.
[20] J. G. Park, R. Jeon Ie, T. D. Harris, *Inorg. Chem.* **2015**, *54*, 359–369.
[21] T.-P. Sheng, X.-X. Fan, G.-Z. Zheng, F.-R. Dai, Z.-N. Chen, *Molecules* **2020**, *25*, 2656.
[22] D. Zhang, T. K. Ronson, J. Mosquera, A. Martinez, J. R. Nitschke, *Angew. Chem. Int. Ed.* **2018**, *57*, 3717–3721.
[23] J. B. Maglic, R. Lavendomme, *J. Appl. Crystallogr.* **2022**, *55*, 1033–1044.
[24] SCIGRESS software version FJ 2.6 (EU 3.1.9) Build 5996.8255.20141202, Fujitsu Limited, Tokyo, Japan, 2013.

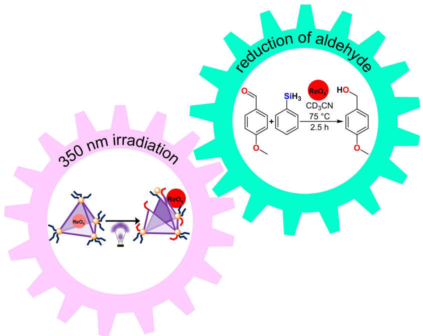
Manuscript received: October 10, 2024
Accepted manuscript online: November 12, 2024
Version of record online: ■■, ■■

Communication

Photoswitchable Catalysis

A. Ghosh, J. D. Thoburn,
J. R. Nitschke* ______________ **e202419575**

Light-Responsive Aldehyde-Reduction Catalysis Through Catalyst Encapsulation



Light is an optimal stimulus to control the functioning of chemical systems, as it is clean, traceless, and easily applied. In this work we demonstrate a new way to couple catalytic activity to light input by encapsulating an aldehyde-reduction catalyst within a cage that opens upon illumination. This concept may enable illumination to be geared with catalytic activity for other reactions, including industrially relevant ones.