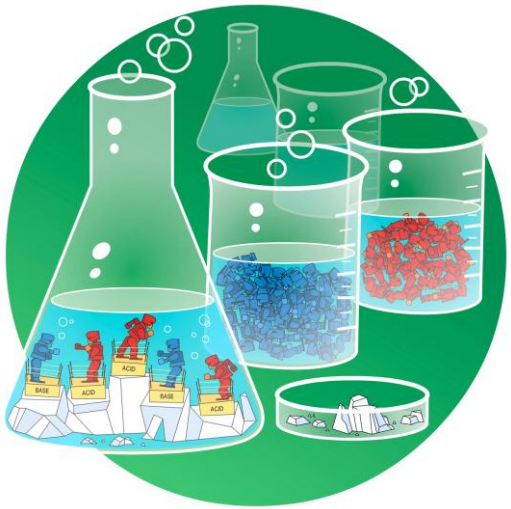
Antagonistic Catalysis: Creating a Bifunctional and Tunable Acid-Base Catalyst

- Researchers have coaxed an acid and a base to work in tandem to trigger chemical reactions. They created a bifunctional surface that combines the advantages of bifunctional enzyme-like catalysis with the ease of separation and robustness of traditional heterogeneous catalysis. They then demonstrated the bifunctional catalytic activity in tandem reactions.
- Retention of the bulk geometrical and electronic properties of the acidic group when incorporated into the surface structure, an important condition for achieving bifunctional activity, was confirmed by comparing bulk and surface X-ray absorption spectra measured at NSLS beamline X18B.
- The team showed the feasibility of having base and acid groups on the same solid support without neutralizing each other. This decreases energy-consuming steps such as separation and purification of intermediates. Their method also reduces the consumption of raw materials.
- By changing the ratio of polyacid and amine groups, the catalyst can be made predominantly basic or predominantly acidic or equally acidic and basic. Similar types of catalysts can be synthesized using other heteropolyacids, further widening the scope of antagonistic catalysis.



In the drawing, a journal cover image, the acid (red) and base (blue) sites are depicted as robots. (The Rock 'em Sock 'em Robots were designed by Marvin Glass and Associates and first manufactured by the Marx toy company in 1964). The antagonist sites are physically separated in private "boxing rings." This physical separation prevents the acid and base sites from attacking each other, creating a truly bifunctional and tunable acid-base catalyst.

Illustration by Itamar Daube
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N. Raveendran Shiju et al., "Mesoporous Silica with Site-Isolated Amine and Phosphotungstic Acid Groups: A Solid Catalyst with Tunable Antagonistic Functions for One-Pot Tandem Reactions," Angew. Chem. Int. Ed. 2011, 50, 9615 –9619