Integrated nanozymes for brain chemistry

April 13 2016

Nanozymes are novel nanomaterials with enzyme mimicking activities, which are superior to natural enzymes and even conventional artificial enzymes. They have attracted considerable attention because they offer the possibility of lowered cost, improved stability, and excellent recyclability. However, the specificity and catalytic activity of current nanozymes are still far lower than that of their natural counterparts, which in turn have limited their broad applications.

To tackle this challenge, Professor Wei and his team from Nanjing University, Nanjing Drum Tower Hospital, and Emory University now report the design and development of integrated nanozymes by confining two cascade catalysts inside a nanostructured metal-organic framework. A major advantage of this integrated design is that the first enzymatic reaction occurs in nanoscale proximity to the second enzyme, so products of the first reaction can be used immediately as substrates for the second reaction, thus overcoming the problems of diffusion-limited kinetics and product instability.

Specifically, a molecular catalyst (e.g., hemin) and a natural enzyme (e.g., glucose oxidase, GOx) have been simultaneously assembled inside a nanoscaled zeolitic imidazolate framework (ZIF-8), and the resulting GOx/hemin@ZIF-8 integrated nanozymes show numerous merits such as enhanced catalytic activity and improved thermal stability. Quantitative enzymatic studies indicate that their integrated nanozymes are able to provide greater than 600 percent enhancement in catalytic activity relative to a simple mixture of hemin@ZIF-8 and GOx@ZIF-8. Their strategy is general and has also been applied to other enzymes (e.g., lactate oxidase/hemin@ZIF-8) and multiple catalysts (e.g., invertase/GOx/hemin@ZIF-8).

More excitingly, this dramatic improvement in catalytic activity has allowed them to construct an integrative detection platform by combining the nanozymes with microdialysis and microfluidic techniques. The platform has been successfully employed for the in vivo monitoring of neurochemicals such as striatum glucose in the brains of living rats following ischemia/reperfusion. Considering the vast numbers of combinations of nanozymes with other artificial enzymes and/or natural enzymes, their current strategy and platform might be extended for a wide range of targets associated with many critical diseases in other living animals and even human beings.

More information: Hanjun Cheng et al. Integrated nanozymes with nanoscale proximity for neurochemical monitoring in living brains , *Analytical Chemistry* (2016). DOI: 10.1021/acs.analchem.6b00975

Provided by Nanjing University