AUTONOMOUS MOVEMENT OF MICRO- AND NANO MOTORS

Reported by Ephraim G. Morado February 23rd, 2017

INTRODUCTION

Motion is a fundamental aspect of living organisms. For instance, humans are able to run and jump by using their muscles to convert chemical energy to mechanical energy. A similar type of energy conversion occurs in nature at the molecular level. For example, the molecular motors kinesin and myosin play a vital role in transporting cargo within the cell by using adenosine triphosphate for fuel to generate movement.[1] With these biological models as an inspiration, scientists have sought to develop biomimetic analogs of these sophisticated motors.

RECENT DEVELOPMENT OF NANOMOTORS

The idea of converting chemical energy to autonomous motion was first developed by Whitesides and coworkers.[2] Their design consist of centimeter sized discs coupled with platinum catalyst that degrades hydrogen peroxide to water and oxygen to create microbubbles that propel the discs forward. This crude device was an early example of a system that demonstrated autonomous movement using chemical fuel. Since the pioneering work by Whitesides, other systems have been developed concentrating on the micro- and nano-scale. Similar nonomotors have been made, usually consisting of spherical or tubular Janus particles using platinum catalyst as the motor.[3-4]

A novel design utilizing a bowl-shaped stomatocyte that encapsulates, a platinum nanoparticle, *via* supramolecular interactions, has been established.[5] Hydrogen peroxide is able to enter the bowl shaped cavity and access the platinum core to produce motion (Figure 1). In addition to having the ability to move, these stomatocytes can undergo conformational changes under thermal stimuli.[6] This thermal impetus is able to open or close the stomatocyte valve to prevent or allow hydrogen peroxide to enter the stomatocyte. This is the first time that control over these nanomotors has been demonstrated.

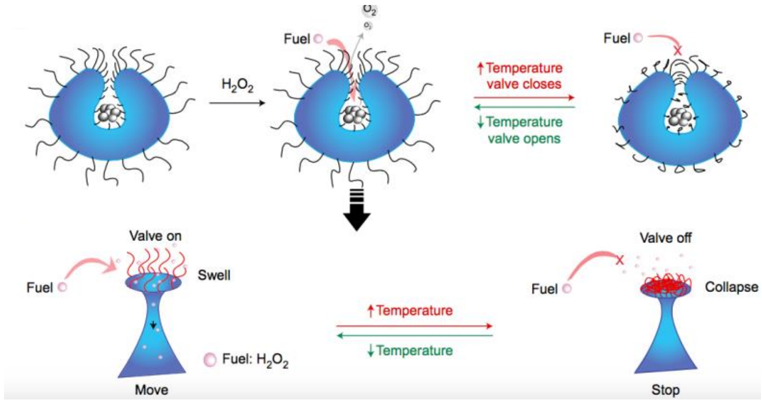

Figure 1. Temperature responsive nanomotor. [6]

CONCLUSION AND FUTURE DIRECTION

So far, scientists have developed a nanomotor that can be controlled by thermal stimuli. However, this and previous nanomotor prototypes share a similar drawback: lack of control in terms of directionality, controlled release of cargo, and conformation. Although having control of speed is important, other key aspects to make this truly biomimetic still needs to be explored such as directionality and selectivity to target specific locations. Only then can these nanomotors be applied to biological systems as mobile drug delivery vehicles.

REFERENCES

1. Vale, R. D., *Science* **2000,** *288* (5463), 88-95.
2. Ismagilov, R. F.; Schwartz, A.; Bowden, N.; Whitesides, G. M., *Angew. Chem., Int. Ed.* **2002,** *41* (4), 652-654.
3. Ma, X.; Hahn, K.; Sanchez, S., *J. Am. Chem. Soc.* **2015,** *137* (15), 4976-9.
4. Abdelmohsen, L. K.; Nijemeisland, M.; Pawar, G. M.; Janssen, G. J.; Nolte, R. J.; van Hest, J. C.; Wilson, D. A., *ACS Nano.* **2016,** *10* (2), 2652-60.
5. Wilson, D. A.; Nolte, R. J.; van Hest, J. C., *Nat. Chem.* **2012,** *4* (4), 268-74.
6. Tu, Y.; Peng, F.; Sui, X.; Men, Y.; White, P. B.; van Hest, J. C. M.; Wilson, D. A., *Nat. Chem.* **2016**.