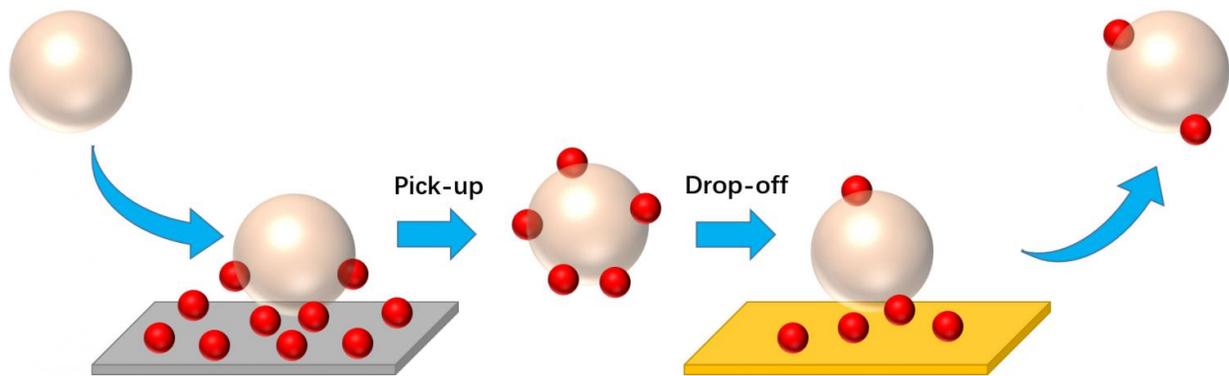


'Nanoparticle taxicab' materials can identify, collect and transport debris on surfaces

November 2 2016



Oil-in-water droplets represented by shiny spheres stabilized by functional surfactants first pick up the nanoparticles, represented by small red balls, when traversing a nanoparticle-coated surface. Later in the same in-line process, when the particle-attached droplets meet the downstream empty surface with a high affinity for the nanoparticles, they drop the nanoparticles off onto the surface and move forward in the aqueous flow. Credit: UMass Amherst/Richard Bai

Inspired by proteins that can recognize dangerous microbes and debris, then engulf such material to get rid of it, polymer scientists led by Todd Emrick at the University of Massachusetts Amherst have developed new polymer-stabilized droplet carriers that can identify and encapsulate nanoparticles for transport in a cell, a kind of "pick up and drop off" service that represents the first successful translation of this biological process in a materials context.

As Emrick explains, "These carriers act as nanoparticle taxicabs. They find particles on one surface, recognize their composition, pick them up and drop them off later on another surface. The work is inspired by the very sophisticated biological/biochemical machinery operating in vivo, found for example in the case of osteoclasts and osteoblasts that work to balance bone density through deposition and depletion of material. We replicated this with much simpler components: oil, water and polyolefins." Details are now online in *Science Advances*.

He and colleagues believe theirs is the first demonstration of surface-to-surface nanoparticle transport or relocation, and suggest that "developing these methods would be exceptionally useful as a noninvasive technique for transferring nanoparticle properties (chemical, optical, magnetic or electronic) from one material to another."

The process is different than conventional cleaning, and nanoparticle encapsulation and release processes "represent a potential route to efficient materials transport and/or recycling processes," they add.

The authors say that "designing materials that mimic the complex function of biology holds promise for translating the efficiency and specificity of cellular processes into simple, smart synthetic systems." Future applications might include promoting cell adhesion, which is necessary for maintaining multi-cellular structures, and drug delivery, for example.

Emrick says he and his UMass Amherst co-authors including Richard Bai, George Chang and Al Crosby sought to adapt such biologically inspired advances in two areas: polymer-stabilized emulsion droplets that pick up [nanoparticles](#) by engulfing them into the droplet's fluid, and droplets that can deposit nanoparticles onto damaged regions of substrates for repair functions.

Their experimental system used hydroxyapatite, a calcium phosphate-rich structure that resembles the principal composition of bone. They assessed pick-up efficiency in several experimental conditions and attempted to establish the versatility of nanoparticle pick up using a variety of inorganic and plastic substrates. The researchers found that pick up was poor from certain surfaces, suggesting that "substrate composition may be exploited to adjust the relative extent of nanoparticle pick up."

Emrick points out that the project, supported by the U.S. Department of Energy's Office of Basic Energy Sciences, also reflects an "atom efficient" method for materials cleaning and repair. Because of its inherent simplicity and conservation of material, atom efficiency is an important concept in the "green chemistry" approach to producing products.

More information: Y. Bai et al. Functional droplets that recognize, collect, and transport debris on surfaces, *Science Advances* (2016). [DOI: 10.1126/sciadv.1601462](https://doi.org/10.1126/sciadv.1601462)

Provided by University of Massachusetts Amherst

Citation: 'Nanoparticle taxicab' materials can identify, collect and transport debris on surfaces (2016, November 2) retrieved 25 April 2024 from <https://phys.org/news/2016-11-nanoparticle-taxicab-materials-debris-surfaces.html>

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