The Leidenfrost effect, first investigated over 250 years ago, is well known as the phenomenon that causes water droplets to hover over the surface of a hot frying pan for several seconds while evaporating. This common phenomenon, which creates droplets in a super-heated state, has now been exploited to fabricate a wide range of nanoscale materials. As described in an article published in *Nature Communications* in October (DOI:10.1038/ncomms3400), researchers from several German research institutions investigated the physical properties of Leidenfrost drops in detail and established that overheating, thermal gradients, and electrical charge separation which occur within the Leidenfrost drops create an ideal environment to promote nucleation of functional nanomaterials.

Gold nanoparticles of 4 nm size were synthesized in a 2-mL drop of dilute HAuCl₄; however, when the OH⁻ concentration within the drop was increased by adding NaOH to the reaction solution, macroscopic, spongy three-dimensional (3D) metal nanostructures were formed. Nanoparticle synthesis, clustering, assembly, and fusion all occur within the levitating Leidenfrost drop (see Figure), and preliminary follow-up investigations show that the morphology, shape, and porosity of the resulting nanoporous metal can be controlled by varying the NaOH concentration.

Alternatively, homogeneous nanostructured coatings can be applied to different substrates *in situ* after the synthesis of nanostructures within the Leidenfrost reactor. To accomplish a uniform coating the substrate is placed inside the drop, which is rotated during the levitation phase. The team led by Mady Elbahri, who holds a joint appointment at the University of Kiel and the Helmholtz-Zentrum Geesthacht, demonstrated that Leidenfrost drops can even be used as nanoreactors to synthesize functional metal–polymer hybrid foams. Such a 3D coating of a complex structure cannot be obtained by conventional immersion synthesis techniques; it requires the unique aspects of a Leidenfrost nanoreactor.

“We understand the chemistry; extending the range of applications for Leidenfrost drop chemistry now necessitates a better understanding of the levitation process. This is the challenge we are working on,” said Elbahri. For now, however, the limiting factors to advancing this new type of charge-driven chemistry are the size of the levitated droplet and its stability.

**Leidenfrost drops prove to be versatile nanoreactors**

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**Nano Focus**

**Origin of nickelate stripe phase uncovered**

Strongly correlated materials often show unusual magnetic and electronic properties, such as high-temperature superconductivity. An example of such behavior is the formation of self-organized electronically ordered phases, which can cause charges to segregate into atomic-scale patterns and is linked to the emergence of high-temperature superconductivity.

An international research team has now illuminated the origins of the so-called “stripe phase” in which electrons become concentrated in stripes throughout a material.

“We’re trying to understand nanoscale order and how that determines materials properties such as superconductivity,” said Robert Kaindl, a physicist at Lawrence Berkeley National Laboratory (Berkeley Lab). “Using ultrafast optical techniques, we are able to observe how charge stripes start to form on a time scale of hundreds of femtoseconds.”

Kaindl, W.-S. Lee (SLAC National Accelerator Laboratory), T. Sasagawa (Tokyo Institute of Technology), and their colleagues reported the results of
research that shows that flagella grow at a constant rate. The unexpected chain mechanism, in which subunits linked in a chain pull themselves through the flagellum, transforms current understanding of how flagellum assembly is energized.

The research team, led by Gillian Fraser and Colin Hughes, found that as each flagellum “nanomachine” is assembled, thousands of subunit building blocks are made in the cell and are then unfolded and exported across the cell membrane. Like other processes inside cells, this initial export phase consumes chemical energy. However, when subunits pass out of the cell into the narrow channel at the center of the growing flagellum, there is no conventional energy source and they must somehow find the energy to reach the tip.

The research team has shown that, at the base of the flagellum, subunits connect by head-to-tail linkage into a long chain. The chain is pulled through the entire length of the flagellum channel by the entropic force of the unfolded subunits themselves. This produces tension in the subunit chain, which increases as each subunit refolds and incorporates into the tip of the growing structure. This pulling force automatically adjusts with increasing flagellum length, providing a constant rate of subunit delivery to the assembly site at the tip.

Co-researcher Eugene Terentjev, of the Cavendish Laboratory, said, “Understanding how polymers move through channels is a fundamental physical problem. Gaining insight into this [research on bacteria] has potential applications in other disciplines, for instance in nanotechnology, specifically the building of new nanomaterials.”