Researchers observe how nanoparticles grow when exposed to helium

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A team of researchers from the University of Leicester and France's G2ELab-CNRS in Grenoble have for the first time observed the growth of free nanoparticles in helium gas in a process similar to the decaffeination of coffee, providing new insights into the structure of nanoparticles.

Nanoparticles have a very large surface area compared with their volume and are often able to react very quickly. This makes them useful as catalysts in chemical reactions and they are often used in sports equipment, clothing and sunscreens.

In a paper published by the *Journal of Physical Chemistry Letters* and funded by the Royal Society, The Leverhulme Trust, the British Council and CONACYT, the teams from the University of Leicester's Department of Physics and Astronomy and the CNRS in Grenoble measured how helium ions cluster with neutral helium atoms and grow into nanoparticles.

During the study they examined how helium ions drift through a cell filled with helium atoms. When the pressure of helium was increased the researchers observed a decrease in the mobility of the ions.

Dr Klaus von Haeften from the University of Leicester's Department of Physics and Astronomy, who has received a Visiting Professorship from the University Joseph Fourier, said: "We concluded that the increased pressure forced more and more helium atoms to bind to the ions

gradually, until the clusters grew to nanometre-sized particles. This process continued until the nanoparticles reached the maximum size possible which also depended on the temperature.

"Further increase of the pressure was found to reduce the size, which we interpreted as compression. These size changes could then be followed in great detail. For low and moderate pressures the size changed rather rapidly whereas in the high pressure region the changes were slow."

By analysing how quickly the particle volume changed with pressure the researchers were able to investigate the structure of the nanoparticles.

Nelly Bonifaci from the G2ELab-CNRS said: "At low and moderate pressure the nanoparticles were much softer than solid helium and we concluded that they must be liquid. At high pressures they became progressively harder and eventually solid."

Dr von Haeften added: "By choosing helium we were able to study a system of greatest possible purity and our results are therefore very precise. Similar processes occur in the decaffeination of coffee in high pressure carbon dioxide, in dry cleaning and in chemical manufacturing. In all these processes nanoparticles grow. By knowing their size we can much better understand these processes and improve them."

This is the first time that researchers have been able to observe the growth of free nanoparticles in a large range of pressure in gaseous helium.

Frédéric Aitken from the G2ELab-CNRS added: "Our work is an important benchmark for the research on the formation and size of nanoparticles."

More information: "Formation of Positively Charged Liquid Helium

Clusters in Supercritical Helium and their Solidification upon Compression." DOI: 10.1021/acs.jpclett.5b01159