Noble gas clusters in a graphene sandwich

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Due to their chemical inertness, noble gases are in gas phase under normal conditions. When trapped between two graphene sheets, however, the exerted pressure presses noble gas atoms together leading to the formation of clusters [1]. We create such clusters by implanting singly charged low energy ions into suspended bi- and double layer graphene, which allows their direct imaging through (scanning) transmission electron microscopy (figure 1) inside the graphene sandwich [2]. While all small clusters (up to at least 14 atoms) remain solid, larger clusters can exhibit either solid- or liquid-like structures depending on their size, chemical element and possibly local microscopic environment. In general, Xe clusters appear more solid than Kr ones (figure 2).

References

[1] Längle, M., Mizohata, K., Åhlgren, E., Trentino, A., Mustonen, K., & Kotakoski, J., Microscopy and Microanalysis, 26(S2), 1086-1089
[2] Rasim Mirzayev, Kimmo Mustonen, Mohammad R. A. Monazam, Andreas Mittelberger,Timothy J. Pennycook, Clemens Mangler, Toma Susi, Jani Kotakoski, Jannik C. Meyer, Science Advances 3, e1700176 (2017)

Figures

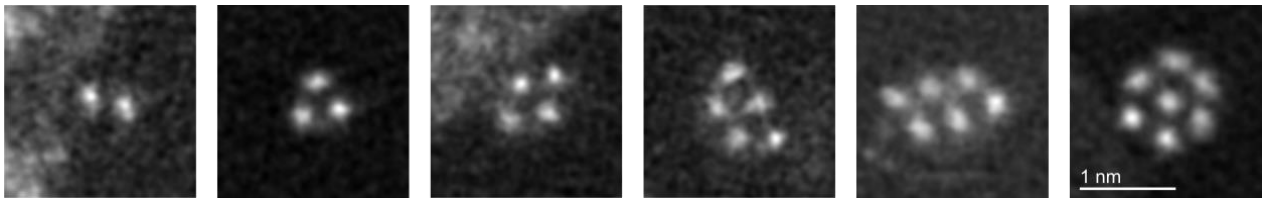

Figure 1: Filtered annular dark field scanning transmission electron microscopy images of Xe clusters to up to seven atoms.

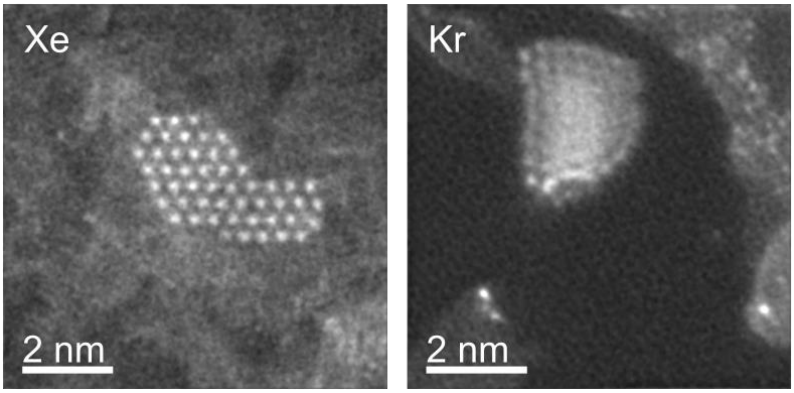

Figure 2: Filtered annular dark field scanning transmission electron microscopy images of a Xe_{51} cluster and a Kr cluster of a comparable size.