

Capturing neon within crystalline frameworks to aid semiconductor manufacturing

Neon is one of the least reactive elements known. No molecules containing neon have so far been synthesised and it is the only stable element that has never previously been studied within an organic crystal structure, despite 80 years of academic research in the area.

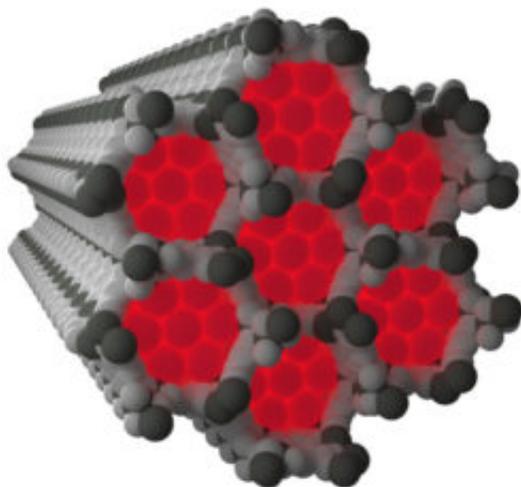


Fig. 1. Neon bound within the nickel-based crystalline metal-organic framework (NiMOF-74).

The inert gas, neon, is mostly famous for its use in neon signs. It's also a key component of excimer lasers, used in the manufacturing of semiconductor chips for computers, tablets and mobile devices. Despite being the fifth most abundant element in our atmosphere, neon is highly expensive to produce. It is carefully extracted by distillation of air, a process that is inefficient and which negatively impacts the cost of semiconductors used in computers.

Experimental studies at the U.S. Department of Energy's Advanced Photon Source (APS) have now resulted in the first structural observations of neon captured within a porous crystalline framework. Metal-organic frameworks (MOFs) are highly tuneable structures based on metal ions and organic linkers. They are commonly crystalline and frequently porous, which means that they are well suited to capturing and separating different gases.

Two different metal-organic frameworks were analysed to determine if they adsorbed neon gas strongly enough to "see" the neon atoms using X-ray diffraction. A nickel-containing MOF (NiMOF-74) was found to be most effective framework for neon adsorption of the systems analysed. At low temperatures (100 K) and high neon gas pressures (100 bar) the neon gas was

even observed to form a significant non-covalent interaction with the exposed nickel metal centres. The observed interaction with a transition metal, along with the amount adsorbed, indicates the potential for further tuning frameworks to be even more effective for neon capture.

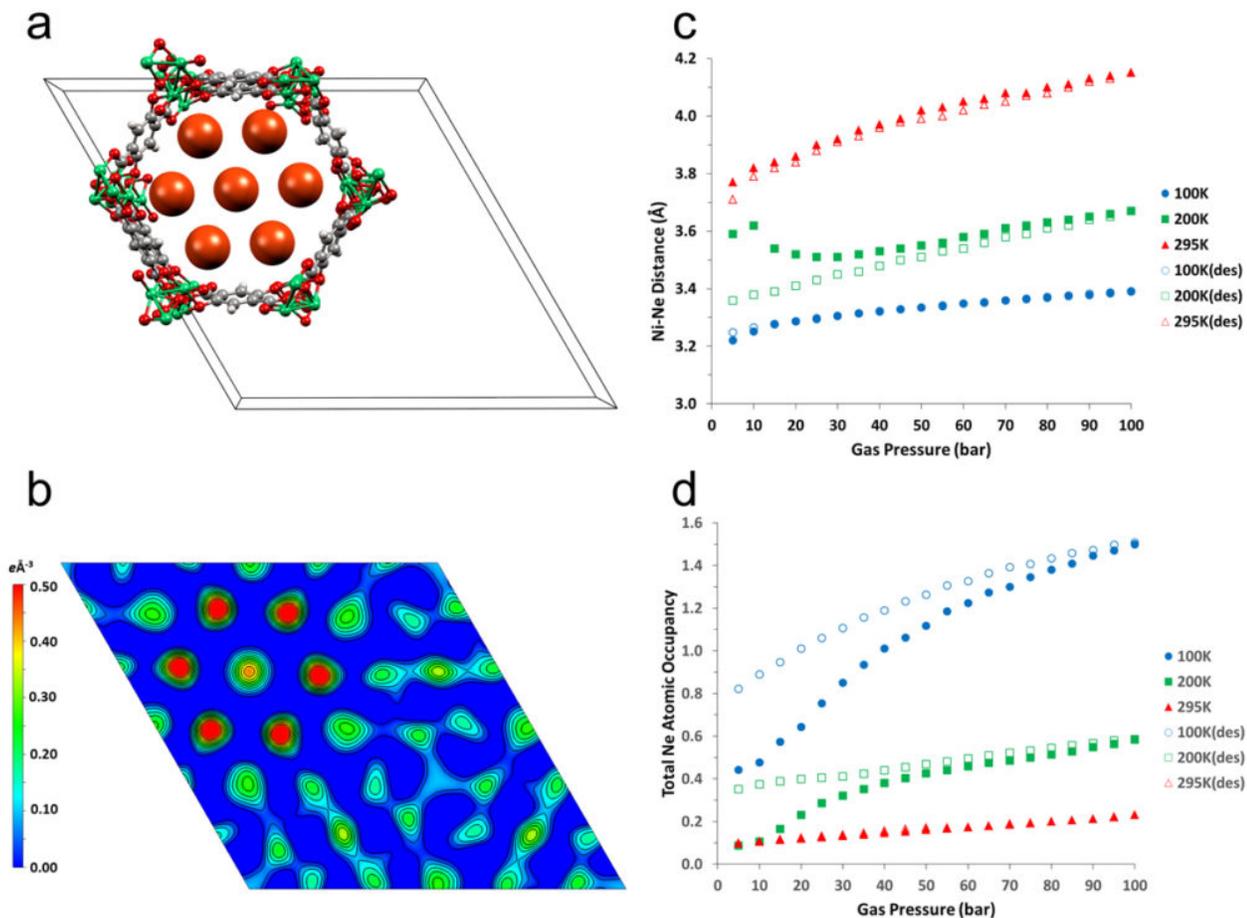


Fig. 2. Details of neon adsorption within NiMOF-74. (a) Neon observed experimentally within the pores of NiMOF-74 at 100 K and 100 bar of neon gas pressure. (b) Fourier difference map without guest modelled at 100 K and 100 bar, illustrating peaks in the electron density due to neon. (c) Ni–Ne distances as a function of gas pressure upon adsorption and desorption. (d) Total neon atomic occupancies as a function of gas pressure upon adsorption and desorption.

Not only is this the first time that neon has been studied within such a framework. These results point the way towards the design of tailored frameworks for neon extraction, potentially reducing the cost of semiconductor manufacturing. The next step in the research will be to make these frameworks more selective for neon compared to other atmospheric gases.

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Publication

[Capturing neon - the first experimental structure of neon trapped within a metal-organic environment.](#)

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