Physical surface details of mica studied on an atomic scale

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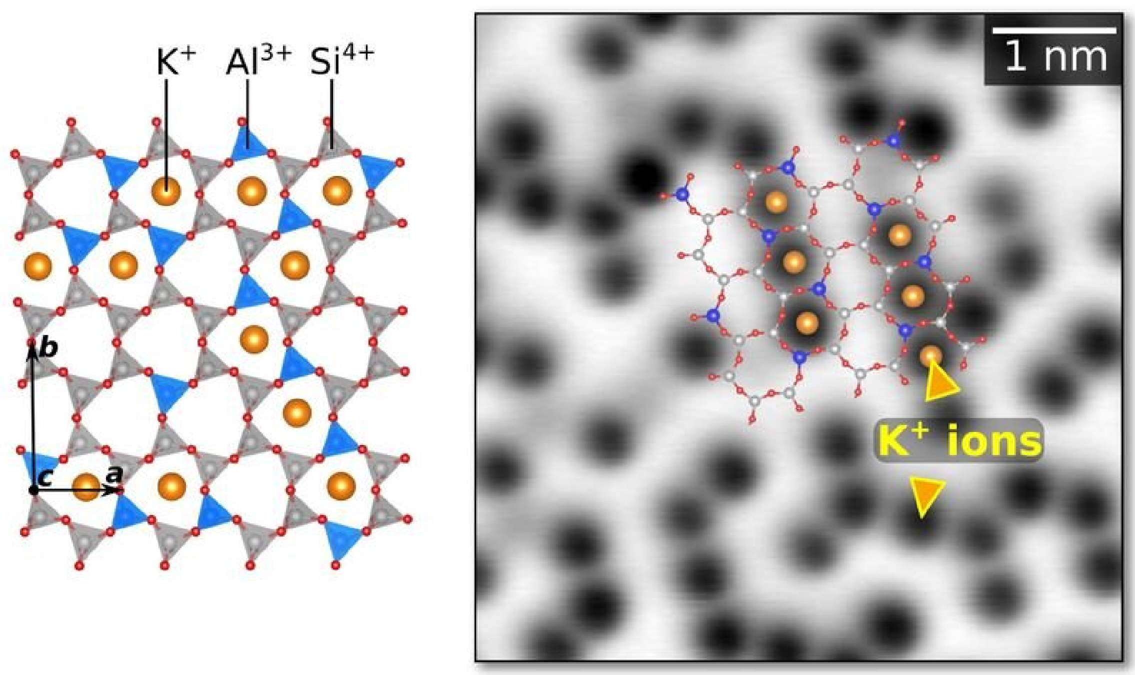

Atomic structure of mica and a picture taken by an atomic force microscope. Credit: Vienna University of Technology

At first glance, mica is something quite ordinary: it is a common mineral, found in granite for example, and has been extensively studied from geological, chemical and technical perspectives.

One might think that nothing new can be discovered from such an everyday material. But now a team from the Vienna University of Technology has presented a study in the journal *Nature Communications*, explaining the distribution of potassium ions on the mica surface. The physical surface details of mica have never been studied on an atomic scale, and this information is important for research on electronics with 2D materials.

Atomically thin layers

Atomically thin–layered 2D materials are currently one of the most researched topics in materials science. Certain materials, such as graphene and molybdenum disulfide, consist of only one or a few layers of atoms, which frequently leads to unusual properties.

In a sense, mica is a naturally occurring 2D material: It consists of atomically thin layers that can contain different atoms depending on the type of mica: oxygen is always present, often silicon, often potassium or aluminum as well. The layer structure of the mica is also the reason for its characteristic sheen—you can often see a spectrum of colors, similar to a thin layer of oil on a puddle of water.

Potassium ions in ultra high vacuum

The outermost layer of mica is difficult to examine because it is quickly contaminated by atoms and molecules from the air. The researchers imaged the surface of mica in an ultra-high vacuum, using a new type of atomic force microscope at the Vienna University of Technology.

"We were able to see how the potassium ions are distributed on the surface," says Giada Franceschi, the first author of the current paper, who works in Prof. Ulrike Diebold's team. "We were also able to gain insights into the positions of the aluminum ions under the surface layer —this is a particularly difficult task experimentally."

The images show that the potassium ions are not randomly distributed on the surface, as previously assumed, but are arranged in tiny patterns. These distributions could also be calculated with the help of computer simulations.

Matching insulator for 2D electronics

This work could be important for, among other things, attempts to use 2D materials such as graphene for electronic circuits. Suitable insulators are needed for this, and mica is a very obvious candidate.

"The surface properties of mica will play a crucial role in such electronic components," says Giada Franceschi.

More information: Giada Franceschi et al, Resolving the intrinsic short-range ordering of K+ ions on cleaved muscovite mica, *Nature Communications* (2023). DOI: 10.1038/s41467-023-35872-y

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