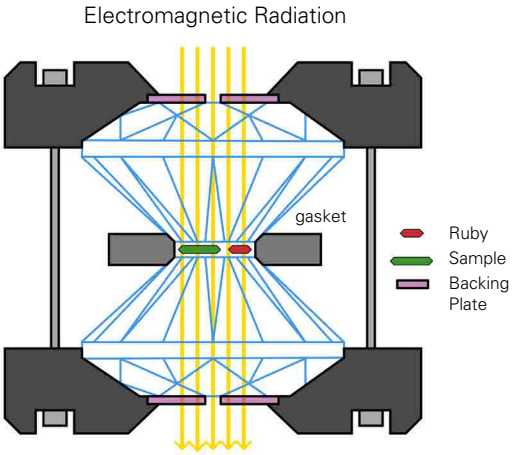
Vicky Wong

The bizarre world of high pressure chemistry

Sodium metal is pale grey and shiny when first cut.

What would happen if you put some sodium, normally a soft, pale grey metal, under extremely high pressures? When chemists tried this the results were not as they expected and as yet cannot be fully explained.



A diamond anvil cell; the sample is held between two diamonds; there is also a ruby which is used to indicate the pressure.

The research was done using a piece of apparatus called a diamond anvil cell. It contains two diamonds and as the screws are tightened it is in between these that the high pressure is created. The pressure between the diamond tips can reach 1000 gigapascals, which is about 10 million times atmospheric pressure. Electromagnetic rays can be passed through the sample chamber to allow measurements to be taken of what is inside.

Using the diamond anvil cell to produce high pressures has allowed chemists to create some new materials including superconductors. They have also allowed some geochemical processes to be examined and have allowed scientists to study what happens to the materials believed to be in the Earth's mantle at the high pressures found there. It is not possible to access the mantle directly so there are few other ways of studying this. Two of the iron oxides in the mantle, Fe_2O_3 and Fe_3O_4, were found to decompose at the high pressures releasing oxygen and forming the very unusual Fe_5O_7 and $Fe_{25}O_{32}$.

When sodium is squeezed to 190 gigapascals it turns from being a pale grey metal to being transparent, with see-through crystals. It also loses another property of metals and instead of being a conductor is now an insulator. The change in properties shows that there is a change in the structure and bonding of the sodium, but the current models used by scientists (like the one in the Box: **Bonding**) are not able to predict what will happen to the bonding when chemicals are subjected to these high pressures. Chemists are now working to try to improve their models, with the hope that they will allow the prediction of possibly useful properties.

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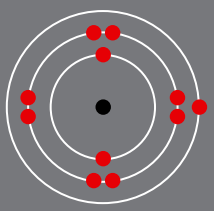
Bonding



Sodium at room temperature and pressure has a metallic structure. How does this relate to its atomic structure?

Sodium atoms have 11 electrons. Two of these fit into the first energy level, eight into the second energy level with the last in the third energy level. These outer shell electrons are delocalised and can move about in metallic sodium, allowing it to conduct electricity.