Another 'trophy' for the chemistry cabinet

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(Phys.org) —The search for cleaner, low temperature nuclear fuels has produced a shock result for a team of experts at The University of Nottingham.

First they created a stable version of a 'trophy molecule' that has eluded scientists for decades. Now they have discovered that the bonding within this molecule is far different than expected. Remarkably their findings have shown that it behaves in much the same way as its counterparts in the well-known transitional metals such as chromium, molybdenum and tungsten.

The research, done by PhD student David King, which could help in the extraction and separation of the two to three per cent of highly radioactive material in nuclear waste, was led by Professor Stephen Liddle in the School of Chemistry, and has been published in the prestigious academic journal *Nature Chemistry*.

Professor Liddle said: "The major motivation for doing the first piece of research was to understand the nature of the chemical bonding of uranium. Now we have extended the series to enable meaningful comparisons the 'shock' is that whereas the bonding would be expected to be very different to commonly known and well understood transition metal analogues the bonding is in fact very similar. This is a real surprise and could have an effect on nuclear clean up because differences in chemical bonding are exploited in the separation processes.

Building on previous advances

Working with experts in the Photon Science Institute at The University of Manchester, their latest discovery builds on their previous advances in this area of chemistry, published in the academic journal *Science* last year.

With funding from the Royal Society, European Research Council, and Engineering and Physical Sciences Research Council the team first established the method to make the 'title molecule'. For the first time they prepared a terminal uranium nitride compound which was stable at room temperature and could be stored in jars in crystallized or powder form.

Previous attempts to do this required temperatures as low as -268 °C—roughly the equivalent temperature of interstellar space—therefore these compounds have, until now, been difficult to work with and manipulate, requiring specialist equipment and techniques.

Exploiting the bonding process

Professor Liddle said: "What the nuclear industry wants to do is minimise the volume of waste by extracting the radioactive elements from spent fuel. This relies on exploiting differences in the bonding, but in some circumstances it may be surprisingly similar and this is going to be important in the amelioration of nuclear waste clean-up and devising new atom-efficient catalytic cycles."

The way atoms behave in uranium bonding is still unclear and there is much debate and great interest in respect to the nature of uranium nitride materials because they have the potential to offer a viable alternative to the mixed oxide nuclear fuels currently used in reactors. Nitrides exhibit superior high densities, melting points and thermal conductivities and the process this team of researchers has developed could offer a cleaner, low temperature route reducing the amount of impurities which are difficult to remove from the waste produced by current fuels.

More information: www.nature.com/nchem/journal/v … full/nchem.1642.html

Provided by University of Nottingham