Graphene sniffs out dangerous molecules

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Researchers at the University of Manchester have used the world's thinnest material to create sensors that can detect just a single molecule of a toxic gas.

The development of graphene-based devices – which could eventually be used to detect hidden explosives at airports and deadly carbon monoxide in homes – is reported by Dr Kostya Novoselov and Professor Andre Geim in the latest issue of Nature Materials.

Three years ago, Manchester scientists discovered graphene – a one-atom-thick gauze of carbon atoms resembling chicken wire. This incredible new material has rapidly become one of the hottest topics in materials science and solid-state physics.

Now the same Manchester team has found that graphene is extremely sensitive to the presence of minute amounts of gases such as alcohol vapour or extremely toxic carbon monoxide.

They say this sensitivity was unexpected and seems to contradict to the common belief that graphene is extremely chemically inert.

The researchers have shown that gas molecules gently attach themselves to graphene without disrupting its chicken wire structure. They only add or take away electrons from graphene, which results in notable changes in its electrical conductance.

Writing in *Nature Materials*, researchers from the Manchester Centre for

Mesoscience and Nanotechnology, say they have demonstrated that graphene-based sensors allow individual events to be registered when gas molecules attach to the surface.

Dr Novoselov, from The School of Physics and Astronomy, says this is clearly observed in changes of the electrical resistance of graphene, which occur as molecules are attaching one by one to its surface.

“This level of sensitivity is typically millions of times higher than for any other gas detector demonstrated before,” says Novoselov. “Graphene sensors are as sensitive as sensors can be in principle.”

Novoselov and Geim believe graphene-based gas detectors could be readily commercially produced using epitaxial graphene wafers, grown in many laboratories around the world and already good enough for this application.

But they stress that further research is needed to make such detectors sensitive to individual gases.

“At present you could not sniff out a flammable substance hidden in luggage because an increase in air humidity would give false readings,” says Geim. “But this is exactly the same problem that all solid-state gas detectors have encountered, and it can be successfully solved through various detection schemes including filters and analysis of a temperature response. We see no reason why the same cannot be done successfully with graphene.

“This is only the first step on the route to commercial graphene-based sensors but the road ahead is clear,” adds Geim. “Once again, graphene has proved itself to be a material with truly remarkable qualities, allowing observations that no other known material could.”

Source: University of Manchester