Pioneering research to assist in creation of nanomachines

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A pioneering team from the University of Leicester is seeking to harness a force of nature- only measured accurately a decade ago – to help develop the technology of tomorrow.

Their work will have applications in what is considered to be science fiction where miniscule submarine-type machines might be used to destroy cancer cells.

The research group is believed to be the only group in the UK carrying out Casimir force measurements of smooth and patterned surfaces and assessing the utility of the force for nanotechnology.

The research arises from the quantum fluctuations of vacuum, part of quantum field theory, which at present is the universal theory describing the behaviour of all quantum particles.

The Casimir force is a subtle consequence of the vacuum fluctuations, which can be directly measured using the tools of nanotechnology, specifically atomic force microscopes.

Results of the research may lead to frictionless bearings and may solve one of the fundamental problems in nanomachines.

The research, led by Chris Binns, Professor of Nanoscience in the Department of Physics and Astronomy, is not only of fundamental interest. It is hoped that it will be able to harness the Casimir force as a

way of transmitting force without contact in nanomachines, ie machines with components approaching the size of molecules.

He said: “Generally nanomachines are science fiction and so it is up to the imagination about what they could do but one of the most talked about potential use is in medical applications where submarine type machines might be used to identify cancer cells and destroy them.”

Normally in such machines the Casimir force is a problem, because at the small distances between components the force is quite strong and generates a fundamental ‘stickiness’ to everything, which is impossible to remove.

Professor Binns’ research is trying to turn the problem on its head, and to utilise the Casimir force as a useful way of transmitting force without contact, for example patterning surface to produce the lateral force in which one patterned surface can drag another one in the same direction.

The force was first accurately measured about 10 years ago and nanoscientists are currently trying to find ways to modify and use it, for instance in lateral force.

Professor Binns commented: “The research is at a fundamental level, so at this stage we only hope to determine how the force varies between surfaces composed of different materials and how patterning the surface changes it. Also, we want to measure the magnitude of the lateral force between surfaces.

“One new area we are starting to look at, however, is to measure the force between a normal material and a ‘metamaterial’. A metamaterial is a surface with a designed nanoscale patterning that gives strange optical properties.

“There are indications that with the right sort of patterning it may be possible to reverse the force to produce repulsion. This would have huge technological repercussions and lead to, for example, frictionless bearings, as well as getting rid of the stickiness problem in nano-machines.

“This is exciting research because it is controversial. Not everybody believes that a repulsive force is possible.”

Source: University of Leicester