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ENERGY INTERVIEW

Energy all around us could power under-skin implants and sensors in aircrafts – Dr Gonzalo Murillo

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by Steve Gillman

Dr Gonzalo Murillo says that piezoelectric materials, like nano flakes, could lead to self-powering microchips. Image credit: Dr Gonzalo Murillo

There is unlimited kinetic energy all around us and harnessing it could change the way we interact with the world forever, according to Dr Gonzalo Murillo from the National Microelectronics Center of Spain, whose research into piezoelectric materials has earned him an award for the most novel innovator under 35 in Europe 2016 from the MIT Technology Review, US.

What are piezoelectric materials and how do they work?

'Piezoelectric materials are commonly crystalline materials that can convert mechanical stress into electric fields. Basically when you press, release, or apply other mechanical forces on it, you can rearrange the charges inside the materials and generate an electric voltage.

‘A good example is a lighter, when you press it you get a spark, this is also a piezoelectric material. You have a conversion of the mechanical energy into electricity.’

Why are they interesting to us?

‘In the near future we will have over a trillion sensors and electronic systems that will be capturing information, talking to each other, sending info to the cloud and computing everything. In order to have this big amount of sensors we need to get rid of batteries and have systems that don’t need them. One of the main objectives of my research is to be able to power all these small smart sensors with piezoelectric materials.’

You discovered an innovative way to harness piezoelectric energy during the EU-funded SINERGY project, what was it?

‘I’ve been working on piezoelectric materials for nine years and I did my PhD on this topic too. I studied different materials and different technologies, then for SINERGY I developed some nanostructures that can be used to harvest this energy (picking it up and storing it until it needs to be used). I used nanostructure materials like nano wires and nano plates, or nano flakes, of piezoelectric materials which are very small and thin so they become very flexible and are also very useful with tiny forces.

> ‘One important source of mechanical energy is the human body.’
>
> *Dr Gonzalo Murillo, National Microelectronics Center of Spain*

‘The good point with this technology is that it’s compatible with microchips. In principle in the same chip you can have the electronics, the piezoelectric materials, and the storage.’

What other uses could these energy-harvesting microchips have?

‘Another specific application is predictive maintenance, which is a concept where you can monitor machines through several parameters, like temperature or acceleration, and then predict or control when the machine is going to fail, before it actually fails. If you take a look at a graph of cost versus time of failure, you will see it increases exponentially and the maximum cost point is when it fails, but if you are able to detect when the machine is going to fail you can save a lot of money.

‘You can also save money in aeroplanes, like the Airbus A380, you have around 6 000 sensors inside. Right now they are connected by kilometres of wires so the cost of the wiring of an aeroplane is really high. It seems now they are starting to work on wireless sensors for aircrafts and that’s a good idea because you will get rid of cables. But you will still need to power the sensors and piezoelectric materials can help. Imagine having 1 000 sensors in an aeroplane and replacing batteries for each one.’

It sounds as though there could be major applications for industry, but what impact could piezoelectric materials have on our day-to-day lives?

‘Other applications of piezoelectric materials, especially nanostructures, will be the impact on devices that you can have under your skin, because one important source of mechanical energy is the human body. Imagine devices that can deliver drugs into your body or a timer that can do a drug delivery without any sort of external systems.

‘(Another) application is with the interaction between the electronics we have in our hands, like our cell phone or Google glasses, all these kind of devices we have now out of our body. The interaction could become closer, we could have all these materials closer to our bodies, for instance we might see a type of Bluetooth implant someday.’

What’s next for your research?

‘We are trying to create a spinoff or start-up company, to transfer the knowledge from the research centres to a company. The main application where there is interest is with a gas utility company from Spain (who want to use piezoelectric sensors) to monitor the entire distribution network of gas and electricity. We can adapt our generators to monitor the fluxes of electricity and gas, to create smart grids or detect leakages. We can also get energy from here.

‘In SINERGY, everything was focused on the development of silicon-compatible materials for the energy harvesting. I was in charge in all of the parts of this piezoelectric approach, but we had a special focus on these nanostructure materials. This work isn’t finished yet, but it will be continued in another new project called ENSO.’

More info

SINERGY

ENSO