RICK SMALLEY INTERVIEW

Rick, tell me about C60.

C60 is also known as the “buckyball”. Imagine a soccer ball with its seams arranged in a pattern of pentagons and hexagons. If you sit and count the vertices, you’ll find that there are precisely 60 of them – just like the carbon 60 molecule. 60 is a remarkable number. It turns out that it is the largest number of objects you can arrange around the surface of a sphere and have each be identical to every other one by a simple rotation. 60 also has more integral factors than any other number, and any range of numbers, if 60 is inside that range or some multiple of 60. It is this factorability of 60 that gave the Babylonians reason to use it as the basis of their number system. And it’s reason that around the world we divide the hour into 60 minutes and the minute into 60 seconds.

What sort of special genius does the carbon atom have wired into it?

Carbon has a genius for forming a one-atom-thick membrane, the sheet of which graphite is made. In this graphite sheet – called graphine – each carbon atom is connected to just three others, very much like the vertices in the hexagonal mesh of chicken wire. In graphite, carbon stays defiantly 2D in a 3D world. Carbon is the key connective entity in organic molecules and there’s a way of binding its atoms together that not only gives you the versatility of organic chemistry but also magnificent electrical conductivity in the form of buckytubes, which are the best conductors of electricity of any molecule that we’ve ever discovered. The buckytube is for electrons what a single node optic fibre is for photons. It’s a single node wave-guide for the transmission of electrons.

I understand your research group at Rice University has the motto "If it ain't tubes we don't do it."

That's right! And we've recently formed The Carbon Nanotechnology Laboratory whose tag line is "We're going to make buckytubes be all that they can be."

And what is that?

Not only do buckytubes have incredible electrical conductivity, but we believe that the tensile strength of these tubes will almost certainly be the strongest, highest tensile strength of any fibre ever made in the universe. The thermal conductivity down these tubes has been measured to be at least 50% higher than diamond, which previously had the highest known thermal conductivity. So the electrical properties are unmatched, the mechanical and the thermal properties are unmatched. Our challenge is to make these incredible properties of the individual nanometer-wide tubes become manifest on the macroscopic scale, in real world applications.

What types of tools do you work with at the nano scale?

We produce nanotubes by way of chemical tricks. We don't actually go in with magic fingers and pick up individual atoms and build these tubes one atom at a time! We now have six different ways of making buckytubes – some of which are being commercialized right now. And we continue to look for new ones. What we'd like to get – and I'm confident we will get – is an industrial scale method that will allow us to make a particular type of buckytube with perfection, in hundreds of millions of tons a year around the planet at low cost.

Where are we now in terms of the application of nanotech to real world problems?

That really depends on how you define nanotechnology. In my definition, we are already very far along that road. I view nanotechnology as simply a technology whose power is determined entirely by our ability to manipulate atoms at the nanometer scale and build structures. But the overall structure need not be nanometer in size; it could be something big enough to hold in the palm of your hand. Seen this way, modern engineered polymers fit the definition. Even nylon would have been a nanotechnology in its day. And pretty much every drug that you take is a nanometer scale molecular entity which, if you changed any atom in it, wouldn't work the same way. These are all nanotechnologies. The new stuff with buckyballs and buckytubes is within its first decade and will take another decade or so before it has a huge impact.

I know you're passionate about the world's energy challenge. How are you feeling about it these days?

I'm feeling pretty good because I can imagine that there is, in fact, at least one good clean answer to how we can provide the energy we'll need for about ten billion people on the planet by 2050. I suspect that over the next ten years we will be able to get a major research program of the magnitude of Apollo to make this come to pass. There are probably in the order of ten miracles that need to happen: stunning breakthroughs in the physical sciences and engineering that will enable the world to run on a new kind of oil – an energy technology for the 21st century that will be the basis of prosperity, as oil was in the last century. I believe that this new energy technology, if you had to describe it with a single word, would not be hydrogen. It would be electricity as the connective tissue that brings us all together.

We're headed toward a world powered primarily by solar energy, wind, renewable biomass, and likely quite a bit of nuclear. But, increasingly, the lion's share of the world's energy will come from the sun directly: photons that hit our houses, giant solar farms in the great deserts of this world, and solar energy beamed down to earth in the form of microwaves from solar collectors in orbit around the earth – or perhaps even on the moon.

When we imagine a global energy grid, what is the role of nanotechnology?

Take the interconnected electrical energy grid we have now – in North America, for example – and add a local storage facility for electrical power at every house and every business. These would function like uninterruptible power supplies, providing 12 to 24 hours of buffer from whatever happens on the grid. This means that your peak load is taken care of from your own storage and you buy energy off the grid when it's cheap, at night. Primary power would come to the grid from existing and new power plants. To this scenario, we add efficient long distance transmission of electrical power, which would certainly not be carried along aluminium or copper wires. It will a much more efficient wire. One way or another, nanotechnology's got to find the answer.

Tell me about the magnificent opportunity with our energy challenge right now.

I believe that in the energy debate we're having around the world, and very intensely right now in North America, there is a high ground that's currently not occupied by any of the principal political parties. It's a high ground because it is not selfish. It's pro-development and pro-environment. Taking on our energy challenge now will do more to address the rich-poor divide than any other single thing. I can think of no greater mission than to use this wondrous new nanotechnology that's being developed to solve humanity's need for clean energy.

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both the National Academy of Sciences and The American Academy of Arts and Sciences. He was awarded the 1996 Nobel Prize in Chemistry.