Single Crystal Graphene: The next manufacturing frontier

We don’t often think about crystals being capable of bending without breaking, but a single crystal of graphene will be rather flexible. In the world of graphene language is important and it will help you dear InvestorIntel reader to find out why this is the case…

The current state of the art for making graphene

Commercially available graphene is available in tonne quantities. These are manufactured as platelets, nano platelets or nano sheets. They are usually sold as powders dispersions and pastes that can be used as additives in products such as rubber tyres, carbon composites and paints.

Larger sheets of graphene can be made at square centimetre scale by the chemical vapour deposition (CVD) method grown on surfaces such as solid copper and silicon. These surfaces are not completely smooth and this creates imperfections in the resulting graphene layer making it polycrystalline. This CVD graphene is essentially a batch process and not currently suitable for making the material on anything other than sample scales. Graphene sheet made by this method has been found to be suitable for flexible touchscreens, but does not have the strength needed for other uses.

So at the moment graphene can be made in very tiny pieces or as imperfect samples.

On perfection…

The size and perfection of the sheet is necessary to realise the amazing properties of graphene. Think about the metaphor

of a chain. We all know that a chain is only as strong as its weakest link. CVD graphene could not realise the promised strength of the perfect material because the defects introduce weak links across the sheet. Now imagine a chain where all the links are separate. It doesn't matter what are the properties of the individual links, it cannot be used as a chain unless the links are embedded in some glue like material. This is one of the reasons nanoplatelets are used as additives in composite materials.

Close to perfection

Perfection in graphene terms is a sheet of carbon where all the atoms are connected by bonds to form hexagons. This pattern is uninterrupted and continuous through the entire sheet, be it on the nano-scale, metre-scale or kilometre-scale. This is what scientists mean by a single crystal. In essence there is a continuous two-dimensional chain of bonds throughout the whole material.

If you think perfection is impossible, you would have been right until a few weeks ago. Researchers at Peking University in China have made single crystal graphene on copper foil that they claim is almost perfect at 99.9% alignment.

However, the graphene must be removed from the solid growth surface and this separation damages the sheet, and makes graphene by a batch process. The continuous manufacture of single crystal graphene is not quite there yet. The next step will probably be when the researchers start to perfect the growth of graphene on liquid surfaces as we outlined in a previous column entry.

So What…

Well, if you could make single crystal graphene by a

continuous process a myriad of amazing industrial products would result.

Just one example: Architects would be freed to create a whole new range of super tall skyscrapers. Elevator technology is one of the main constraints placed on the height of skyscrapers. At the time of writing the tallest building is 828m (0.8Km) high.

A layered graphene elevator tether ribbon would allow people to be carried right to the top of tall buildings in one smooth action without having to change elevators which would bring in a new age of kilometre and mile high buildings. All this is foreseeable now the manufacturing frontier has been extended into single crystal graphene technology.