Bayer leads CNT and NanoSilver Commercialization in Composites and Printed Electronics

Abstract:

Carbon nanotubes (CNTs) and nano silver (Ag) continue to be among the most popular and well developed nanomaterials displayed at the nanotech 2010 exhibition held during Feb. 17-19 in Tokyo. As one of the world's leading company to produce high-quality multi-wall CNTs (MWCNTs) in large volume (capacity 260 tons), Bayer MaterialScience continues to promote their CNT-Al composite with their partner Zoz group. In addition, Bayer showcased their development products on printable conductive nano inks, which enable the printing processes from inkjet and gravure printing to screen printing. BayInk TP CNT not only enables the mass production of low-cost, flexible printed electronics, it is also suitable for use in the temperature-sensitive substrate. BayInk TP Silver provides even higher conductivity than BayInk TP CNT and higher resolution below 50 µm.

During February 17th to 19th 2010, nanotech 2010 was held at the Tokyo Big Site. At this world's largest annual nanotech conference and trade show (over 650 worldwide exhibitors), we find that nano carbon and nano silver (Ag) materials as well as their applications are still among the most popular and developed nano materials. A number of companies have developed value-added technologies and products based on carbon nanotubes (CNTs) and Ag nano particles displayed at this exhibition. Companies such as Bayer MaterialScience (Bayer), Applied Nanotech Inc. (ANI, US), Hitachi Chemical Co. Ltd (Japan), Applied Carbon Nano Technology Pte Co. Ltd (CAN, Korea) and Bioneer (Korea) showcased their CNT based composites or inks. Bayer and ANI have also developed printable nano Ag inks. We interviewed Dr Horst Adams, Vice President of Bayer Future Tech Branch, Dr Klaus Hummert, Managing Director of Powder Light Metals GmbH and Dr Stefan Bahnmueller, R&D Project Manager for Functional Films R&D Center at Germany Pavilion.

Since a new pilot production unit with an annual capacity of 200 metric tons of multi-wall CNTs (MWCNTs) became operational at the end of 2009, Bayer is now the world's largest MWCNT supplier with an annual total production capacity of 260 metric tons for high-quality MWCNTs (trade name: Baytube). This is the second time for Bayer to promote their CNT-Aluminum (Al) composites on Japan nanotech exhibition. With MWCNTs are dispersed in an Al-matrix by mechanical alloying, the resulting powder material is then consolidated to composite by Bayer's partner, Powder Light Metals GmbH. These CNT-Al composite can be 3 times as stiff as the conventionally used Al. The weight reduction depends on the concentration of CNTs in Al-matrix. "CNT staying at grain boundaries of Al after mechanically alloying effectively block the dislocation movement," Dr Hummert said it when he

explained why the CNT-Al composites can be as strong as steel. Zoz Group also showcased the high-end mobility vehicles using these CNT-Al composites. Working together on a co-operative project, Zoz Group is utilizing Baytubes to manufacture high performance semi-finished products (rods and complex bars) as well as fasteners (nuts and bolts) (trade name: Zentallium) and applied them to develop high-end mobility vehicles. The annual production capacity of the CNT-metal composites in Bayer reaches 50 metric tons in 2010. The timeline for the application of Zentallium on sport equipments, automotives, construction and aerospace will be 1 year, 2-3 years, 5-10 years and 10 years respectively, considering the testing time as well as the public acceptance to new technology.

At nanotech 2010, Bayer presented two development products on printable conductive inks BayInk TP Silver and BayInk TP CNT developed primarily for use in the growing “printed electronics” market. BayInk TP CNT contains the Baytubes. The large viscosity range enables production of switches and other electronic elements using a variety of printing methods, especially suitable to the large-scale printing processes such as screen printing and gravure printing. The electrical conductivities are higher than 5000 S/m and no sintering is required, which not only means energy savings but is also a key benefit for use in temperature-sensitive substrates. The Bayer water-based nanosilver dispersion can be used to produce conductor tracks and circuits using inkjet technology with the resolution well below 50 µm. Sintering is required and the temperature can be kept in the range of 140 °C to 180 °C. This results in outstanding conductivities up to 35 % of that of bulk silver, depending on the sintering conditions and formulation. The printed circuits using Bayer inks are not transparent, “but it can be hardly detectable because of the high resolution well below 50 µm,” said Dr Bahnmueller.

These new inks have excellent adhesion to plastic films, other flexible substrates, glass, silicon and indium tin oxide (ITO). This makes them ideal in supporting the concept of flexible, inexpensive electronics such as manufacturing RFID chips and certain film displays. They also have the potential for use in conventional electronic components, replacing existing processes such as metal deposition and etching. Currently the market for printable conductive nano ink is warming up and Bayer MaterialScience is actively seeking development partners in printable electronics market value chain.

Fig. 1. Left: BayInk sample and the printed flexible conductive circuits on the transparent substrate; Top right: semi-finished products (rods and complex bars) as well as fasteners (nuts and bolts) made by Bayer CNT-Al composites, which is as strong as steel and as light as Aluminum; Bottom right: Zoz mobility vehicles using Zentallium.