

SEMICONDUCTOR



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FOCUSED ON EMERGING SEMICONDUCTOR COMPANIES

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Startup Profiles

Vorbeck Materials

Vorbeck Materials was established in July 2006 to manufacture and develop applications using Vor-x, Vorbeck's graphene material. Vorbeck recently secured \$5.1 million in Series 2 financing led by Stoneham Partners, a private investment firm, with contributions from the Maryland Department for Business and Economic Development and a syndicate of individual investors. The company will use the capital to expand development of its Vor-x graphene and Vor-ink conductive inks for printed electronics applications. Vorbeck has 20 employees.

Graphene is a one-atom thick sheet of carbon atoms in a crystal lattice. Graphene possesses unique electronic properties and is recognized as the strongest, most thermally and electrically conductive material known. However, until now, the manufacture of single-sheet graphene on a ton scale has not been commercially feasible.

In response to this industry need, Vorbeck has licensed core technology from Princeton University to develop a unique, scalable process for manufacturing graphene in ton quantities. With exclusive technology licenses from Princeton, industrial-scale manufacturing capacity, and development programs with industry leaders

in electronics, energy, and transportation, Vorbeck is demonstrating graphene's immediate potential in real-world products.

Vorbeck is poised to break some barriers previously encountered with classical graphitic materials. With excellent conductivity, surface areas over 1,800 m²/g, outstanding dispersability and stability, and sinter-free performance, Vor-x™ has been able to differentiate itself from traditional and nano fillers.

Vor-x™ increases the conductivity of polymers and formulations by orders of magnitude. It improves tensile modulus, strength and fracture toughness. It can raise the thermal degradation and the glass-transition temperatures. It reduces the coefficient of thermal expansion and improves dimensional stability, impedes solvent swelling, and enhances gas permeation resistance.

Vor-ink fills the performance gap between traditional carbon-filled & conductive polymer inks and metal inks. Vor-ink has better surface resistivity (ohm/sq) than conductive composites and carbon-based inks while being less expensive than metallic inks.

Since it is not metallic, Vor-ink does not need to be sintered to obtain its rated conductivity. Vor-ink can be dried and cured under the same conditions as graphic inks. Vor-ink can be used with standard drying/curing/fusing

equipment and inexpensive, but temperature-sensitive, substrates such as paper, paperboard, and label stock, saving both capital and operating expenses.

Vorbeck's Vor-x graphene formulations and composites harness the exceptional conductivity of graphene to enable ultra-flexible and robust inks and coatings for the printed electronics market. In energy applications, Vor-x delivers demonstrable performance gains by breaking traditional technology trade-offs between battery capacity and power output. Vor-x™ functionalized graphene-based battery electrodes enable a long-lasting, high-powered battery with enhanced cycle life. Plastic and rubber composites with low Vor-x loadings attain extreme levels of strength, dimensional stability, conductivity, and environmental resistance, opening new application and design possibilities.

Vor-ink comes in a variety of grades for the development of specific applications.

Vor-ink enables new applications in the printed electronics industry through its ease of processing and exceptional conductivity. Based on Vorbeck's Vor-x graphene technology, Vor-ink requires no sintering and employs eco-friendly solvents. Vor-ink creates robust films with outstanding flexibility and crease resistance. Even in thin coatings (1 micron), Vor-ink maintains its rated conductivity.

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(Continued from page 1)

Vor-ink gravure is formulated for the specific needs of gravure printing applications, and provides good coverage at low film thicknesses and high printing speeds. Vor-ink screen is specifically formulated for screen printing applications. For RFID tag applications, the processability of Vor-ink allows direct printing on label stock, paper, and cardboard, lowering production costs and materials costs.

Excellent flexibility and performance makes Vor-ink a direct-printing solution for keypads and inexpensive and flexible backplanes for electroluminescent lighting and displays. For sensor and electrode applications, Vor-ink allows printing of diagnostics and electrodes directly on paper, as well as excellent flexibility and performance on plastic films, to offer new capabilities to your customers.

When added to a plastic or rubber, small amounts of Vor-x™ functionalized graphene can improve the material's stiffness by nearly 10X and can simultaneously improve its thermal stability and its chemical and environmental resistance. Vor-x is also extremely conductive, both electrically and thermally, providing anti-static properties to composites and reducing heat-build up.

Vorbeck works with industry partners in the communications, energy, materials, and transportation industries to develop new products using Vorbeck's technologies. Currently, BASF and Vorbeck have established a joint research program to develop graphene-based formulations and composite materials. As part of the collaboration, Vorbeck and BASF are developing dispersions of highly conductive graphene for producing electrically conductive coating and compounds especially for the electronics industry.

The company is still pre-commercial. External customer trials are just starting, with initial efforts focused on the printed electronics arena.

John Lettow, Ph.D., President (previously co-founder and manager of core technology development for H2Gen Innovations)

John Crain, VP of Strategy and Business Development (previously a Senior Manager within Sprint's Consumer Strategy group, where he led the Emerging Technology and Innovation team)

Gautham Krishnaiah, VP of Finance and Operations (previously a project manager at Grace Davison for the process scale-up and plant installation of new products)

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