Nanomaterials for Real-World Applications

Nanomaterials are known to have amazing properties and are strategically poised to revolutionize many industries. Innovators in the aerospace, computer display, defense, electronics, energy, infrastructure, and power arenas all stand to gain immense benefits from the implementation of nanomaterials in their products. Tens of billions of dollars have already been invested in nanomaterials. To date, however, the returns on investment have been small, as these amazing properties cannot presently be harnessed in real production settings in nanomaterials' native, nano-scaled powder-like form. There is now a way to bridge this gap – Buckypaper. Buckypaper is an ideal product form that can transfer these amazing properties of nanomaterials into real world applications.

Buckypaper consists of nanotubes and/or nanofibers that undergo an innovative process which converts the nanomaterials into an easy-to-handle form, making them ready to be incorporated into existing composite fabrication lines. Since 2000, Dr. Ben Wang and his colleagues have systematically studied the manufacturing process and have evaluated many nanomaterials. Their buckypaper fabrication process and buckypaper quality are repeatable, traceable, and viable. Potential applications of buckypaper include electromagnetic interference (EMI) shielding, lightning strike protection, electronics thermal management, fire protection, and electrodes for fuel cells and batteries, to name just a few.

Dr. Wang and his colleagues know the intricate properties of buckypaper/thermoset composites and the dynamics of production, enabling them to tailor the performance/cost structure to meet a variety of application requirements. Their buckypaper technology was a recipient of the 2007 Micro/Nano 25 Award, the 2008 Nano50 Award in the "products" category, and the 2009 SME "Innovations that Could Change the Way You Manufacture" Award.

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Proof point #2 – advanced prosthetics to improve above-knee amputees' quality of life

To date, 1.5 million Americans have experienced amputations, and on average, 156,000 people lose a limb each year. Currently veterans represent a major O&P need. However, two demographic and medical trends will likely to dramatically change the O&P landscape in years to come: 1) As the 77 million U.S. baby boomers begin turning 65 this year, demand for O&P is exploding, and 2) Obesity and thus diabetes is becoming an epidemic across this country. Many diabetic patients eventually develop complications during the course of their disease where amputation becomes an unfortunate, yet necessary medical procedure. Diabetes-related amputations are rapidly becoming a national medical and social issue.

Prosthetic sockets are an integral part of the prosthesis and current state-of-the-art socket designs face many challenging issues. Most amputees experience daily volume changes which a traditional socket design cannot accommodate. These volume changes affect the fit of the socket and the quality of an amputee's life.

Additionally, elevated temperatures inside a prosthetic socket are also a major detriment causing heat rash and maceration, which can lead to tissue breakdown. Vascular compromise can cause cold extremities, experienced by a large portion of amputations.

Moreover, the ability to monitor and adjust the continuous fit of the socket with pressure sensors would mark a major advancement in modern socket technology. Sensors could provide real-time feedback so the amputee could make adjustments. The practitioner could obtain objective data and precisely diagnose socket issues. These evidence-based indicators will also greatly reduce costs for third party payers.

A multidisciplinary team composed of materials researchers and engineers from Georgia Tech, Florida State University (FSU), an O&P equipment manufacturer (Prosthetic and Orthotic Associates (POA)), two small business engineering firms (Advanced Materials Professional Services, LLC (AMPS) and Tanenhaus and Associates, Inc. (TAI)), and O&P practitioners (St. Petersburg College (SPC), Tallahassee Memorial Hospital (TMH) and VA hospitals) are developing a multifunctional prosthetic socket system that addresses the challenging issues which affect a patient's comfort, functionality gait and mobility.

The advanced prosthetic socket program will provide disruptive technologies to uniquely and positively impact and benefit the following O&P stakeholders:

1. *Patients* – it will provide innovative technologies to advance the quality of life for veterans and other amputees by substantially improving comfort, gait and mobility.
2. *Veteran Affairs* – it will present a cost effective solution so the VA can continue to improve its services to disabled veterans in terms of care, access, quality and satisfaction.
3. *Manufacturers* – with the new SOCAT designs, processes and materials, the manufacturing community can provide advanced and affordable products to ensure customer satisfaction.
4. *O&P Practitioners* – SOCAT's integrated multifunctional material socket will greatly enhance the practitioners' ability to identify patients' needs and determine treatment efficacy.
5. *Insurance industry* – with SOCAT providing sensory data and patient information insurance claim ambiguity will be minimized and help the O&P industry move toward an evidence-based practice.