Nanotech2006

Highlights of Eurasian Biotech Advances

by Cloret Ferguson

Nano-drug delivery, supersensitive bacteria sensors, and *in vivo* nano-detection systems were some of the nanotechnology advances reported at the Eurasian session of the Nanotech2006 conference held in Boston last May. This session was sponsored by the U.S. nonprofit Civilian Research and Development Foundation, which promotes scientific collaboration primarily between the United States and Eurasia.

Dr. Svetlana Gelperina, a leading scientist of the Russian Center of Molecular Diagnostics and Therapy in Moscow, presented the "nanoparticulate drug delivery system," that she and her team developed. The system is capable of overcoming the blood brain barrier (BBB), one of the greatest impediments to effective treatment of deadly brain tumors, such as multiforme gliomas. This breakthrough employs the use of an injectable, nanoparticle-bound form of doxorubicin, used in its "free form" as a conventional chemotherapy drug.

Designed in the injectable, nanoparticulate state, the new type of doxorubicin proved highly effective in producing long-term remission in more than 20 percent of the tested animals, whereas in the control group, all animals died within 20 days. The surviving animals were dissected after three months, and showed "no signs of tumor growth at necropsy."

The treated population of laboratory animals had intracranial glioblastomas, an extremely malignant type of brain tumor. In the United States alone, human deaths from this type of brain tumor range from 12,000 to 15,000 patients per year. (Aside from brain surgery, a very limited number of alternative treatments exists for brain tumors of this type.)

Innovational use of nanoparticles is a noninvasive form of drug delivery to the brain. Another benefit of the nanoparticle-bound drug, which Dr. Gelperina discussed, is that it "is characterized by a significantly improved toxicological profile, being less toxic for [the] heart and testes."

A PET Replacement

In the area of nano-diagnostic technologies, Dr. Yuri Babich, of Ukraine's Institute for Applied Problems of Physics & Biophysics Research Center in Kiev, unveiled a unique replacement for PET (Positron Emission Tomography) and X-ray mammography. The new technology, called Dermal/Transdermal Multiparameter Electrodynamic Imaging (DMEI), is able to detect, identify, and visualize malignancy and its structure to below 1 millimeter in size *in vivo.*

DMEI noninvasively visualizes *in vivo* "dynamics of integral biochemical parameters at tissue, cellular, and subcellular (mitochondrial) levels" in healthy and diseased states. It can produce a mapping of micro-metastases, and detect mitcochondrial abnormalities in cells surrounding the central tumor site.

No such capability has been registered with conventional diagnostic methods, such as PET and X-ray, which may have very poor or no spatial resolution. Usually, PET can only detect tumors greater than 2 millimeters in size. Patients allergic to radioactive diagnostic agents may also find DMEI beneficial.

The technology also utilizes extremely low intensity electromagnetic fields.

The DMEI inventors argue that this new technology costs several orders of magnitude less than that of other well-known methods, an importatnt side benefit. It is also promoted as being an uncomplicated and fast investigational procedure.

Net-shaping with Nanopowders

Tomsk Polytechnic University's Research and Development Centre of Advanced Technologies (Spectr) is directed by Dr. Oleg Khasanov, who addressed the topic of "Nanopowder Net-shaping for Manufacturing Nanostructured Ceramics." Although, the process of "net-shaping" may involve several techniques, in general it refers to manipulating material without significant loss or wastage, by avoiding machining.

The Spectr method applies a powerful ultrasonic vibration (PUV) that "resonates" with the nanopowder-compacting process, eliminating the use of binding agents. Also, the Spectr collector technique "involves specially designed molds, where active and passive shaping-surfaces are combined in one shaping-member of the mold." This mold design reduces the die-wall friction (the resistance that must be overcome to move one surface over another surface).

The result is a complex variety of required shapes composed of compacted nanopowder of uniform density, without gradients of internal stress. These hinder grain growth, warping, and other distortions during the sintering process.

Applications for use of nanostructured ceramics include: the High Temperature Superconductor Crystal (HTSC) shields of magnetic fields; ceramic Superconducting Quantum Interference Devices (SQUIDs) for magnetometry; the cable industry's wire dies and moving rods; the electronics and communication industry's precision dielectric cases of Radio Frequency duplexers; and end seals and impellers of gasoline pumps for tractor and automobile engines. There is also a wealth of potential applications in the nuclear and aerospace industry.