NANO MATERIALS & PROCESSES INC.

NMPI MEDICAL-GRADE NANODIAMONDS

Nanodiamond in Medicine

Detonation Synthesis Nanodiamond (DSND) has unique properties including structural, chemical, biological, mechanical, electrical and optical that make them very interesting to medical researchers.

- Primary particle size of 2-4 nm
- Stable inert structure
- Reactive surface
- Catalytic properties
- Adsorption of impurities
- Ability to form hydrogels
- Bactericidal

According to Edward K. Chow, Ph.D., then a postdoctoral fellow with the G.W. Hooper Foundation and the University of California, San Francisco, "Nanodiamonds possess numerous hallmarks of an ideal drug delivery system and are promising platforms for advancing cancer therapy." http://www.fiercedrugdelivery.com/story/nanodiamonds-may-prove-priceless-drug-delivery/2011-03-13

Some of the recently described applications of DSND in medicine include:

- Nanodiamond-DGEA peptide conjugates for enhanced delivery of doxorubicin to prostate cancer
- Nanodiamond-Epirubicin drug delivery complex to effectively eliminate chemoresistant cancer stem cells
- Increased dosage of Epirubicin without lethality
- Delivery of Doxorubicin to glioblastoma tumors
- Nanodiamond-polymer composites for regenerative medicine
- Materials for drug delivery and imagining systems
- Root canal; gutta percha reinforced with nanodiamonds or nanodiamonds pre-loaded with antibiotics

Articles Regarding Chemotherapy Applications

Promising use of nanodiamonds in delivering cancer drug to kill cancer stem cells, National University of Singapore, Public Release, January 25, 2015
http://www.eurekalert.org/pub_releases/2015-01/nuos-puo012515.php

"As such, delivery of chemotherapy drugs by nanodiamonds not only enables enhanced killing of chemoresistant cancer stem cells, but may be a useful alternative for patients who cannot tolerate the toxic side effects of standard chemotherapy drugs.

Furthermore, the versatility of the nanodiamond-based drug delivery platform opens up the possibility of future applications of nanodiamonds such as the addition of other similar drugs as well as active targeting components such as antibodies or peptides against tumour cell surface proteins for targeted drug release. In addition, the application of a nanodiamond-drug delivery system is not limited to liver cancer. It offers a promising approach to treating a broad range of difficult cancers, particularly those driven by chemoresistant stem cells."

Nanodiamonds Deliver Chemotherapy Drugs Directly to Brain Tumors, UCLA Jonsson Comprehensive Cancer Center
http://magazine.uclahealth.org/body.cfm?id=6&action=detail&ref=1054

"The research was a collaboration between Dean Ho, PhD, of the UCLA School of Dentistry, and colleagues from the Lurie Children's Hospital of Chicago and Northwestern University's Feinberg School of Medicine.

Glioblastoma is the most common and lethal type of brain tumor, with median survival time less than one-and-a-half years. The tumors are notoriously difficult to treat; chemotherapy drugs injected alone often are unable to penetrate the system of protective blood vessels that surround the brain, known as the blood-brain barrier, and those drugs that do cross the barrier do not stay concentrated in the tumor tissue long enough to be effective….

The researchers found that ND-DOX levels in glioblastoma tumors were retained far longer than doxorubicin alone. In addition, ND-DOX was also found to increase apoptosis — programmed cancercell death — and to decrease cell viability in brain-cancer cell lines. The results also demonstrated for the first time that the ND-DOX delivery limited the amount of doxorubicin that was distributed outside the tumor. This reduced toxic side effects and kept more of the drug in the tumor longer, increasing the drug's tumor-killing efficiency without affecting the surrounding tissue. Survival time increased significantly in rats treated with ND-DOX, compared with those given only unmodified doxorubicin."

"Convection-enhanced delivery of nanodiamond drug delivery platforms for intracranial tumor treatment," Nanomedicine: Nanotechnology, Biology and Medicine, August 5, 2013
https://www.infona.pl/resource/bwmeta1.element.elsevier-565c6806-adc3-3418-8294-627b98268b20?locale=en/

> *"Nanodiamonds are multi-faceted carbon-based particles roughly four-to-five nanometers in diameter that can carry a broad range of drug compounds. And while tumor-cell proteins are able to eject most anticancer drugs that are injected into the cell before those drugs have time to work, they can't get rid of the nanodiamonds. Thus, drug-nanodiamond combinations remain in the cells much longer without affecting the tissue surrounding the tumor.*
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Note: additional article references are available upon request.

Medical-Grade Nanodiamond Product Specification

Nano Materials and Processes, Inc. offers medical-grade, detonation synthesis nanodiamond in experimental and commercial quantities. Our product attributes include:

- >90% is 2-4 nm initial crystal size nanodiamonds
- >99% is 2-10 nm initial crystal size nanodiamonds
- Finished product is ~30-50 nm crystals, self-assembled through covalent bonding
- Processed to be free of graphene shell and other impurities to meet government food safety standards
- Certified to meet EU food safety standards by government testing laboratory
- Delivered in sterile, distilled, non-ionized water

Standard packing and order quantities:

- Packaging is one-liter bottles with 5% (+/-) nanodiamond by weight.
- Order quantities are 0.25 kg, 0.5 kg or 1.0 kg of nanodiamonds. Larger quantities are available.

Nanodiamonds in water will initially settle. Over a longer period of time the nanodiamonds agglomerate into larger particles. It is important to agitate the product on a regular basis to reduce settling and the possibility of agglomeration. Particle agglomeration is generally less than 30 nm.

Effective use of our nanodiamond product mandates some pre-treatment. The minimum level of treatment is the use of a high shear mixer to break-up the particles. The best practice is a combination of high-shear mixer and a minimum 400W ultrasonic blender.

Nano Materials and Processes, Inc. provides technical support for this product.

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