Making Mesh Buckypaper Capsules for Transplantation of Cells and Implantation of Medical Devices

NASA has developed an innovative method for fabricating containers ("biocapsules") made of biocompatible mesh for holding living cells and tissues, to facilitate transplantation into the body, for a wide range of high-impact medical applications. The biocompatible mesh (buckypaper) is made of carbon nanotubes (CNTs), and the containers are fabricated by depositing the nanotubes onto pre-formed molds, in order to achieve the desired shape and size of the biocapsule. Various forms are possible, including hollow tubes, closed cylinders, and more complex shapes, determined by the configuration of the mold. The biocompatibility of the capsule makes it possible to implant a variety of cells into a host, even cells that would otherwise be considered “foreign,” such as cells from unmatched donors, specially engineered cells, and even non-human cells. Because the capsule pores are too small for the cells to pass through, the cells stay inside the capsule, where they are protected from the host immune system. The pores of the biocapsule permit gas exchange (oxygen, carbon dioxide), as well as free diffusion of metabolites, proteins and other cell products, which keep the cells healthy, and may provide useful therapeutics. Tissue or tissue fragments, and micro or nanoscale medical devices can also be placed inside the biocapsule to facilitate their implantation into the body.

This technology is available for licensing from NASA’s space program to benefit U.S. industry.

Technology Details

Fabrication of the biocapsule is accomplished by the use of a perforated mold, which allows CNTs in suspension or solution to be deposited by vacuum filtration. Other methods of creating a pressure differential between the outside of the mold and the inside of the mold can be used to drive the CNT deposition process. The mesh builds up gradually, over the course of minutes, so the thickness of the mesh can be controlled by the time of deposition. The fabrication procedure results in a mesh that is held together entirely by entanglement and non-covalent interaction between the CNTs.

Filtration of CNTs onto the surface of a mold as the method of biocapsule fabrication is superior to other methods of fabrication that require assembly from multiple pieces of buckypaper, since these methods require “seams” in order to create a closed container. Seams result in weakness of the biocapsule and can result in leakage of the transplanted cells outside the container, which defeats the immune-shielding function of the biocapsule. The perforated moldfiltration method makes biocapsule manufacture more efficient, and makes possible a wider range of shapes of the biocapsule, to facilitate transplantation into a wider range of sites in the body. The perforated moldfiltration method also allows small beads to be incorporated into the wall of the biocapsule.

Small beads, functionalized with bioactive materials, may be used to maintain the health or enhance the function of the cells inside the biocapsule, or may be used to enhance biocompatibility.

Patent

This technology is protected by a pending U.S. Non-Provisional Patent Application. (Reference No. ARC-16340-1)

Benefits

- Provides potentially more variation in the range of shapes
- Ability to form structures comprised of multiple layers
- No suture or other ligature material is needed
- The system can be sealed up to provide for large-scale reproduction

Contact the Ames Technology Partnerships Office at 1-855-627-2249 or ARC-TechTransfer@mail.nasa.gov