XpresSep™ BSA Ferrofluid (BSA-FF)

Catalog #: BSAFF

1. Product Description

Materials

Supplied	• 1.0 mL BSA Ferrofluid (BSA-FF)
Required	• 20 mM HEPES Buffer, pH 7.5 • XpresSep™ Multipole Magnetic Separator
Storage and Stability	• Materials may be shipped at room temperature, but should be stored protected from light at 4–8°C upon receipt. Do not freeze. The expiration date is indicated on the vial label.

2. Introduction to Ferrofluids

Ferrofluids were invented as part of the space program under NASA. Before liquid oxygen and hydrogen rockets were developed there was a need for transporting fuels in zero gravity. Under NASA such a fuel was developed by taking kerosene and ball milling magnetite in the presence of detergents. The materials that resulted were colloidal suspensions of magnetite crystals (5 to 15 nm) that were coated with detergent molecules (hydrophilic ends onto crystalline services with hydrophobic ends projecting into the fluid phase) that had the fluid properties of the liquids and the magnetic properties of solids.

With appropriate magnetic devices these "fuels" could be moved into combustion chambers. With the development of liquid oxygen and hydrogen rocket engines the use of these interesting materials became obsolete but subsequent research show the utility in a multitude of applications.[i] Some of the interesting properties of ferrofluids include:

(1) in the presence of the magnetic fields their internal density increases (they can float metals!) and their viscous properties increase.

(2) they are only magnetic in the presence of a magnetic field because the crystalline sizes of magnetite are too small to contain a single magnetic domain, making them superparamagnetic

(3) they react to magnetic fields as if they were solids whereby they can literally be lifted out of solution or where they can form odd structures with spikes that follow magnetic field lines.

3. Biologically Active Ferrofluids

Biologically active ferrofluids were invented and patented by Paul Liberti, one of our cofounders. They are manufactured by creating quasi-spherical crystalline clusters of magnetite (40 – 150 nm depending on conditions) which are subsequently coated with protein while they are in a colloidal state. BioMagnetic Solutions' **BSA-FF** are the starting material for all of our conjugated ferrofluids. They are extremely stable and exhibit ferrofluid properties just like their organic phase detergent coated predecessors. Early on Charles Owen and Paul Liberti in collaboration with Gerald Wolf at the University of Pennsylvania demonstrated that BSA ferrofluids form the **natural contrast agent for MRI** as they significantly affect the T2 relaxation time of hydrogen atoms. That seminal work led to one of the more interesting patent controversies in US patent history; - a five-way interference involving Advanced Magnetics, Shering AG, Nycomed, Fox Chase Cancer Institute, Molecular Biosystems and Immunicon (founded by Liberti). [ii]

3. BSA-FF at Immunicon

BSA-FF were adapted by Liberti and his colleagues at Immunicon for use in **ultra-high sensitivity immunoassays**, **cell separation**, and adaptation to **rare cell isolation** in the subsequent development of **CellSearch®**, the first FDA approved system for the detection of circulating tumor cells.

4. Ferrophasing of Ferrofluid

Another interesting application of BSA-FF is a phenomenon termed **Ferrophasing**.[iii] When an aqueous phase is layered over a solution of BSA-FF and an upward pulling magnetic gradient placed above them, the lower ferrofluid will move upward as a phase bringing with it any nonmagnetic components (dyes, RBC, macromolecules) in that phase. Furthermore, if BSA-FF is introduced into a vessel filled with an aqueous solution where a strong magnet has been placed external to the vessel, the ferrofluid will migrate toward the magnet and form a bolus on the vessel wall. That bolus can be moved by repositioning the external magnet and it will remain stable as long as the magnet is in place. If there are non-magnetic components that were added to the ferrofluid before introduction into the vessel, those components will remain in the bolus so formed. The interpretation of this phenomenon is that in the presence of a magnetic field ferrofluid nanoparticles form long North-South pole chains that laterally interact with each other and, because ferrofluids are highly charged, water molecules become ordered within this matrix, **thus forming gel like structures**.

5. Purchasing BSA-FF

Dilute solutions of BSA-FF are offered for study of these interesting phenomena. Larger and more concentrated solutions can be custom ordered.

Safety

The Ferrofluid contains 0.05% Proclin™ 300. This concentration presents no health hazards, toxicology problems, or disposal issues. Please consult the Safety Data Sheet for additional information.

Products are for **RESEARCH USE ONLY** and are not intended for human or animal therapeutic or diagnostic uses.

Warranty

The products are warrantied only against defects in workmanship and quality at the time of delivery. BioMagnetic Solutions LLC makes no warranty beyond the technical specifications of the product. BioMagnetic Solutions LLC liability is limited to either replacement of the products or refund of the purchase price.

[i] R.E. Rosensweig. *Ferrohydrodynamics*. Cambridge University Press, New York, 1985.
[ii] C. de Haen, Conception of the first magnetic resonance imaging contrast agents: a brief history. *Topics in Magnetic Resonance Imaging* 2001; 12(4): 221–230]
[iii] P.A. Liberti. Ferrophasing: magnetically induced gel-like behavior in superparamagnetic iron oxide nanoparticles I. Preliminary results and observations. 2018. See Product Resources at www.biomagneticsolutions.com.