249c Erythrocyte Behaviors in a Dielectrophoretic Microdevice: Blood Types a+, B+, Ab+, and O+

Kellie M. Smith and Adrienne R. Minerick

The use of electrokinetics to distinguish and quantify cellular responses for diagnostic applications is a growing research area. AC electrokinetics have been useful in the separation and movement of a variety of cells [1]. More specifically, nonhomogenous AC fields such as those utilized in dielectrophoresis probe the interior characteristics of cells. This differs from linear electrokinetic tools, which separate or manipulate objects based on surface charge and radius. In this work, the subtleties of blood type (A+, B+, AB+, and O+) responses in a dielectrophoretic field are examined and quantified.

Blood is classified by type based on protein expressed inside the cell as well as on the outer membrane. Type A blood expresses Antigen A and Antibody Anti-B while Type B blood cells express Antigen B and Antibody Anti-B. Type AB blood carries both A and B antigens and no antibodies while Type O blood has no antigens but expresses both antibodies. This is why a Type O person is considered a universal donor while a Type AB person is considered a universal acceptor. Before electrokinetic tools can be used to quantify blood diseases, dependencies due to expression of these blood type antigens and antibodies need to be fully characterized.

A custom microdevice is utilized to characterize the responses of A+, B+, AB+, and O+ erythrocytes in a dielectrophoretic field. Due to the polarizability of red blood cells, they are susceptible to resonant AC frequencies in the MHz range [2]. It is known that genetically or geometrically similar cells have similar, but still distinct, resonant frequencies. A microdevice constructed with 100 micron platinum wires sandwiched between two nonconducting plates was mounted on a Zeiss Axiovert 200M inverted light microscope with a high resolution Axiocam video camera. Blood samples were stored in 1.8 mg K2 EDTA anticoagulant per mL blood in a refrigerator at 5oC. Test aliquots were prepared by diluting whole blood with physiologically balanced 0.143M sodium phosphate buffer just prior to being loaded into the microdevice chamber.

In the dielectrophoretic field, the blood cells align into pearl chains and aggregates in either regions of high field intensity or regions of low field intensity. These behaviors are quantified as a function of a) field frequency, b) field intensity, and c) length of time in storage. The data presented could help develop new DEP microdevices for rapid, point-of-care blood typing methods. It could also serve as a baseline from which abnormalities in blood due to disease or physiological imbalances can be measured.

[1] Pethig, R. “Dielectrophoresis: Using Inhomogeneous AC Electrical Fields to Separate and Manipulate Cells” Crit. Rev. Biotechnol. 16(4): 331-348. 1996

[2] Minerick, A., Zhou R., Takhistov, P., and Chang, H. Electrophoresis. vol. 24, pp. 3703-3717, 2003.