Probing Red Blood Cells Interaction in Presence of Nanoparticles by Optical Tweezers

A Popov[1], T Avsievich[2], Y Tarakanchikova[2], A Bykov[2], and I Meglinski[3]

[1] *VTT Technical Research Centre of Finland, Oulu, Finland*
[2] *Optoelectronics and Measurement Techniques Unit, University of Oulu, Oulu, Finland*
[3] *School of Engineering and Applied Science, Aston University, Birmingham, UK*
Contact Email: alexey.popov@vtt.fi

Nanomaterials have become an essential and indispensable component of our lives. They are used for a variety of fields, from water purification to materials strengthening, from cosmetics to anti-bacterial surfaces and drugs. The abundance of nanomaterials increases the probability of their contact with human tissues and organs. This, in turn, raises concerns about possible adverse effects on human health. With the advent of personalized nanomedicine, this aspect requires even more attention.

One type of widely used and versatile materials is titanium dioxide (TiO_2) and zinc oxide (ZnO). They are used for paints, anti-fogging windows, sunscreens, toothpastes *etc.* and show properties of promising drug carriers. Intravenously injected drugs are inevitably exposed to red blood cells as to the largest fraction of the blood constituents. Mutual interaction between red blood cells is of significant importance. Unbalancing (both increase and decrease) of the involved interaction forces is non-desirable: stronger forces resulting in enhanced adhesion of cells to each other might decrease local oxygen supply to tissue cells and organs and cause ischemia, while weaker interaction forces can cause intensified and more frequent hemorrhages. From the other side, the compromised initial situation can be cured by proper selection of drugs leading to the norm.

In this study, the influence of semiconductor TiO_2 and ZnO nanoparticles on red blood cells was studied by means of optical tweezers. This technology provides a unique opportunity for non-destructive inspection of red blood cells and characterization of mechanical forces at a pico-Newton level within the cell natural environment (blood plasma). Our studies showed negligible changes in the interaction forces in presence of the above-mentioned particles. In contrast, nanodiamonds demonstrated a more pronounced effect or even morphological changes of red blood cells.