New study unveils novel technology for plasma separation using magnets

July 30 2021, by Joohyeon Heo

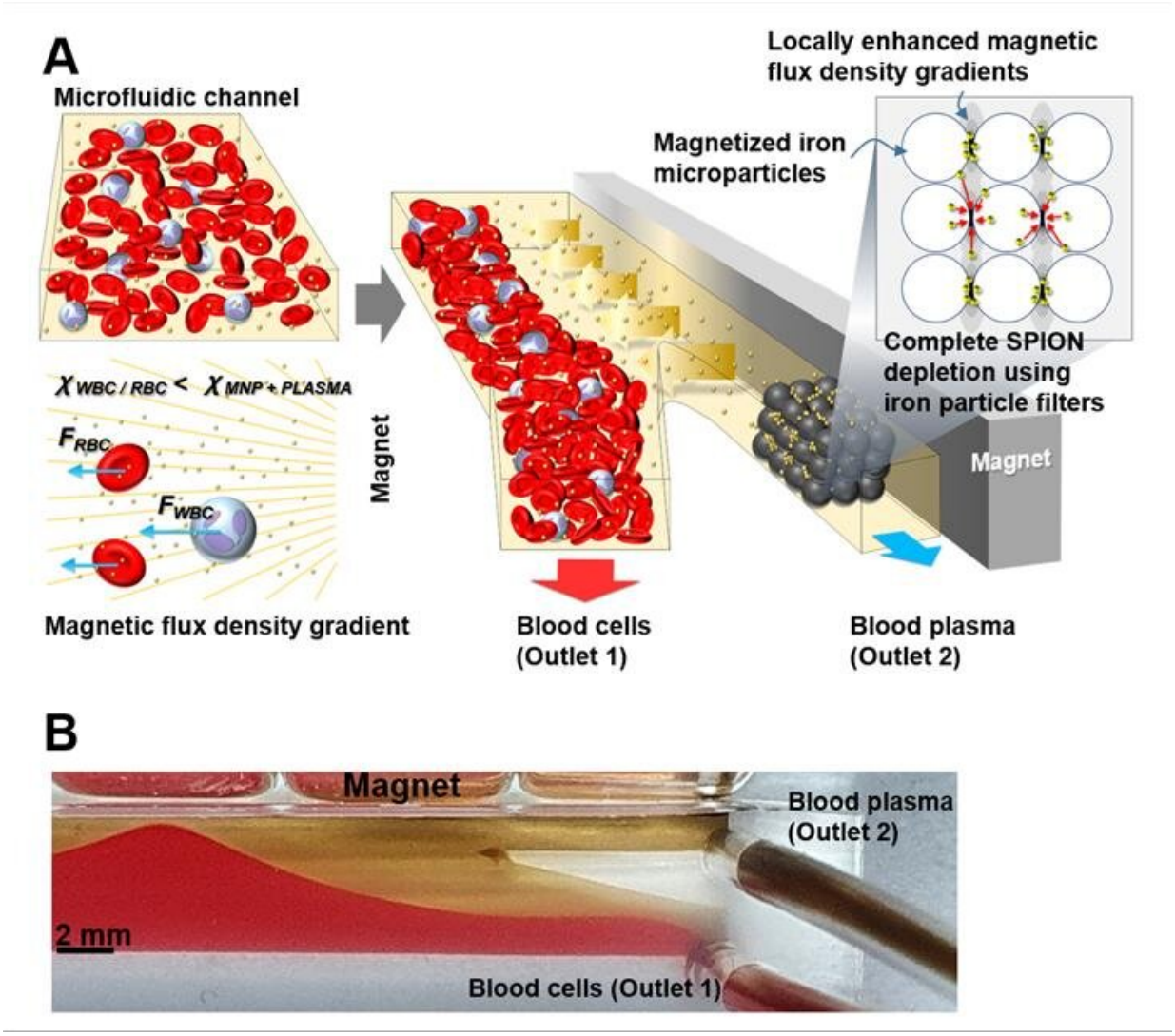

Figure 1. (A) A schematic illustration of the microfluidic device for blood plasma separation using diamagnetic repulsion of blood cells. (B) An image showing red blood cells diamagnetically repelled by permanent magnets. Credit:

A team of researchers, affiliated with UNIST has recently unveiled a hemolysis-free and highly efficient blood plasma separation platform. Published in the May 2021 issue of *Small*, this breakthrough has been led by Professor Joo H. Kang and his research team in the Department of Biomedical Engineering Department at UNIST.
The research team expects that the new technology will greatly improve the accuracy of point-of-care blood tests, which has shown the increased demand recently.

In their study, the research team used diamagnetic repulsion of blood cells to separate blood cells and blood plasma. Once superparamagnetic iron oxide nanoparticles (SPIONs) are supplemented to whole blood, the SPIONs turn the blood plasma into a paramagnetic condition, and thus, all blood cells are repelled by magnets. The research team collected hemolysis-free plasma without loss of plasma proteins, platelets, and exosomes.

"Many efforts have been made to develop various blood plasma separation methods. However, there always have been limitations, such as dilution of blood, blood cell impurity in plasma, and hemolysis," noted Professor Kang. "Our approach overcame these unmet challenges and we could provide a huge impact on in vitro diagnosis once this platform is translated into a commercial point-of-care device."

The developed blood plasma separation method achieved 100% of the plasma purity and 83.3% of the plasma volume recovery rate without noticeable hemolysis or loss of proteins in blood plasma, which was elusive with the conventional plasma separation devices. Moreover, this method enabled the greater recovery of bacterial DNA from the infected

blood than centrifugation and immunoassays in whole blood without prior plasma separation.

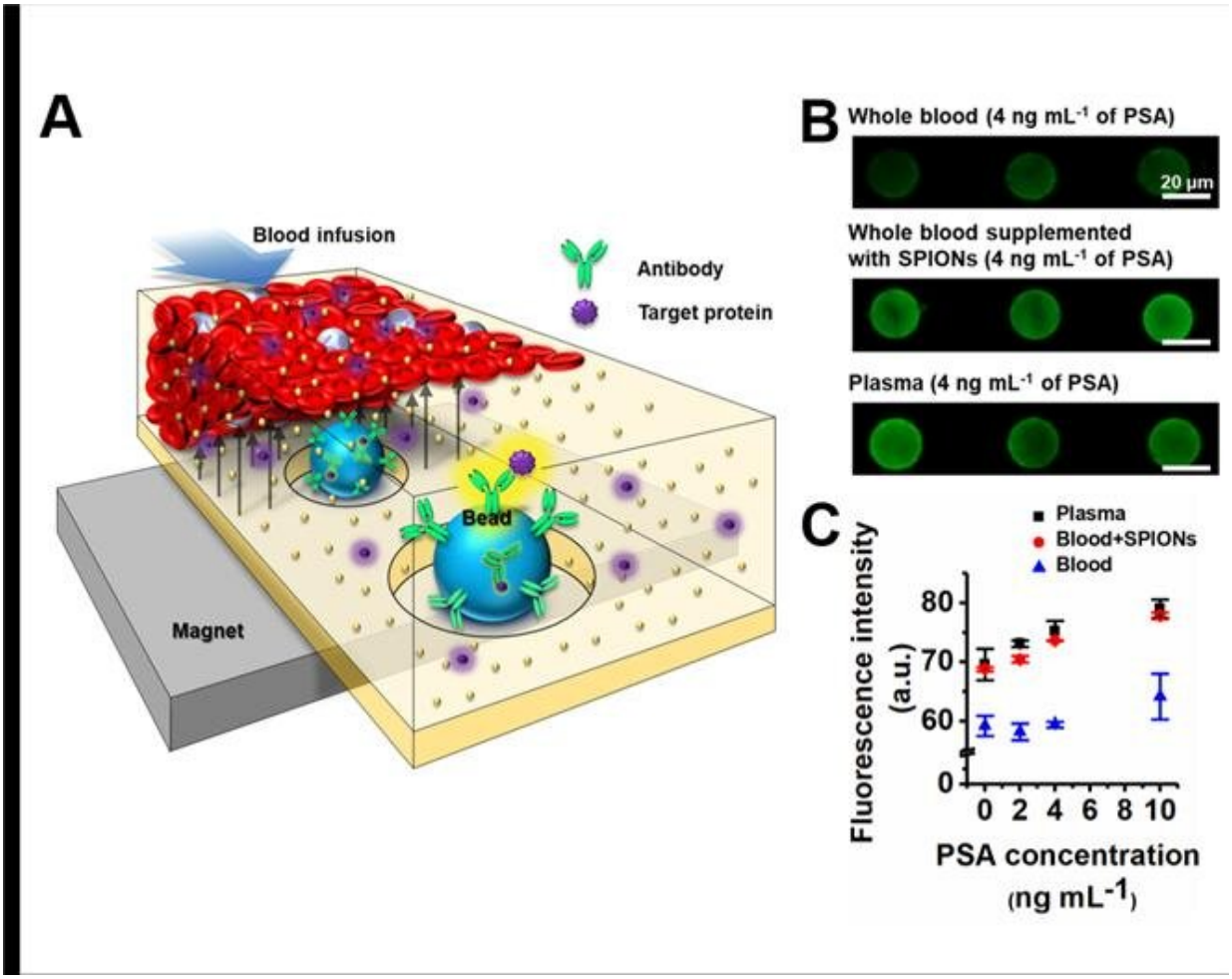

Figure 2. Clinical applications of the diamagnetic plasma separation method for biomarker detection. Credit: Ulsan National Institute of Science and Technology

"We have overcome the limitations of a filter-based blood plasma separation method that potentially could induce hemolysis or a microfluidic chip-based plasma separation method that has the problems in a plasma recovery rate and purity," says Research Professor Seyong

Kwon in the Department of Biomedical Engineering at UNIST, the first co-author of the study.

The research team also developed an ultra-compact, low-cost, high-precision diagnostic chip that can test blood directly without plasma separation. The diagnostic chip detected prostate-specific antigen (PSA) protein, a biomarker for prostate cancer diagnosis.

The developed blood plasma separation method also allowed them to collect platelet rich plasma (PRP). This capability is important because recent studies have revealed that platelets could be used as a biomarker for diagnosis of cancer or diabetes. "Unlike a complex process of the conventional centrifugation method to collect PRP, our method can simply collect PRP by just tuning flow rates," says Jieung Oh, the first co-author of the study.

This study has been jointly carried out by Min Seok Lee of the Department of Biomedical Engineering at UNIST also participated in this study. This work was studied in collaboration with Professor Joonwoo Jeong and Research Professor Eujin Um in the Department of Physics at UNIST. The findings of this research have been published in the online version of *Small* on May 12th, 2021 and selected as a back cover image. This work was supported by Samsung Research Funding Center for Future Research, the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) and Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education.

This study has been jointly carried out by Professor Joonwoo Jeong and Professor Eujin Um from the Department of Physics at UNIST. It has been also participated by Min Seok Lee from the Department of Biomedical Engineering at UNIST. It was made available online in May 2021 ahead of final publication in *Small* in June 2021.

More information: Seyong Kwon et al, Enhanced Diamagnetic Repulsion of Blood Cells Enables Versatile Plasma Separation for Biomarker Analysis in Blood, *Small* (2021). DOI: 10.1002/smll.202100797

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