Mass-Spectrometric Identification of Proteins and Pathways Responsible for Fouling on Poly(ethylene glycol) Methacrylate Polymer Brushes

Tomáš Riedel[1], Zuzana Riedelová[1], Andres de los Santos Pereira[1], Diego Fernando Dorado Daza[1], Filip Dyčka[2] (Arial 10)
[1]Institute of Macromolecular Chemistry Czech Academy of Sciences, Heyrovského nám. 2, Prague, Czech Republic
[2]Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic

riedel@imc.cas.cz

The prevention of protein fouling from blood plasma is a critical challenge in various biomedical applications, and significant research efforts have been dedicated to addressing this issue. The development of surface coatings that exhibit antifouling properties has seen substantial progress, with poly(ethylene glycol) (PEG) emerging as a widely recognized and effective solution. PEG and its derivatives, such as the dense PEG-like cylindrical brushes of poly[oligo(ethylene glycol) methacrylate] (poly(OEGMA)), have demonstrated remarkable potential in drastically reducing fouling from blood plasma proteins.

In this study, we present a comprehensive investigation into the variation of blood plasma fouling on poly(OEGMA) coated surfaces. Our research delves into the detailed analysis of protein deposition on these coatings after exposure to blood plasma from a diverse pool of donors. By examining the composition of the protein deposits, we aimed to identify the underlying mechanisms that influence the antifouling performance of poly(OEGMA) surfaces. Our findings reveal a significant correlation between the fouling behavior of blood plasma on poly(OEGMA) coatings and the composition of the deposited proteins. Notably, we observed that the activation of the complement system plays a pivotal role in the dramatically increased and accelerated deposition of blood plasma proteins on these antifouling surfaces. This activation occurs predominantly through the classical pathway of the complement system, which has been identified as the main contributor to the observed fouling phenomena.These results align with previous studies on PEGylated drug carriers, where similar issues of complement activation have been noted. The insights gained from this study underscore the importance of thoroughly understanding the interactions between antifouling coatings and their surrounding biological environment. Such understanding is crucial not only for optimizing the design and application of antifouling surfaces but also for anticipating potential challenges that may arise when these coatings are used in real-world biomedical contexts.

In conclusion, while poly(OEGMA) coatings offer promising antifouling properties, our research highlights the need for careful consideration of the complement system's role in protein fouling. The study provides a valuable contribution to the ongoing efforts in developing more effective and reliable antifouling strategies, paving the way for improved performance of biomedical devices and materials in contact with blood plasma.

References

[1] Riedelová Z., de los Santos Pereira A., Dorado Daza D.F., Májek P., Dyčka F., Riedel T. Mass-Spectrometric Identification of Proteins and Pathways Responsible for Fouling on Poly(ethylene glycol) Methacrylate Polymer Brushes. Macromolecular Bioscience, 24 (6), art. no. 2300558

Figures

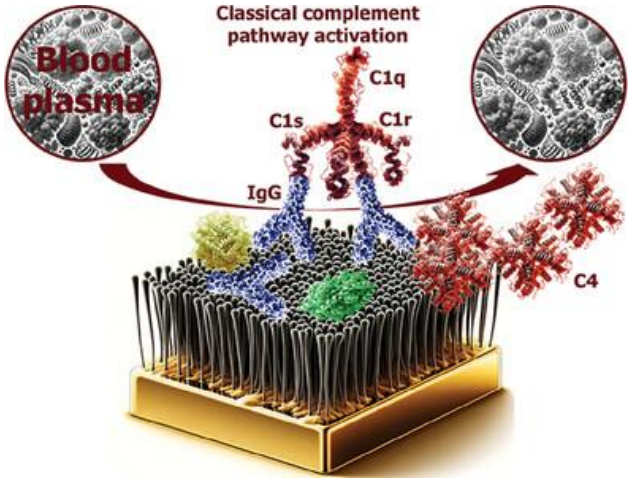

Figure 1. Scheme of polymer brush blood plasma interaction with focus on a classical complement pathway activation.

Acknowledgement

The work was supported from European Regional Development Fund-Project "Excellence in Regenerative Medicine" (No. CZ.02.01.01/00/22_008/0004562).