

About the Potential of Proteinaceous Microfabrication in Biomedical Applications

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We review recent developments of photo-induced protein cross-linking and proteinaceous microfabrication. Observed during photo dynamic therapy, photo-induced protein cross-linking [1] became a tool to cell analysis [2] and microfabrication [3-5]; light absorption induces radical chain reactions that leads to polymerization. Microstructures with submicron-sized features and arbitrary shapes for various applications have been reported [4,5]. Laser direct writing (LDW) is utilized for fabrication, where a fs-pulsed laser localizes polymerization to the focal volume of the laser beam (Figure 1). After summarizing fabrication concept as well as recent advances and applications, we discuss the promising outlook and challenges of proteinaceous microfabrication. Considering the various types of proteins with biomedically relevant functions, proteinaceous microfabrication has a broad potential for biomedical applications.

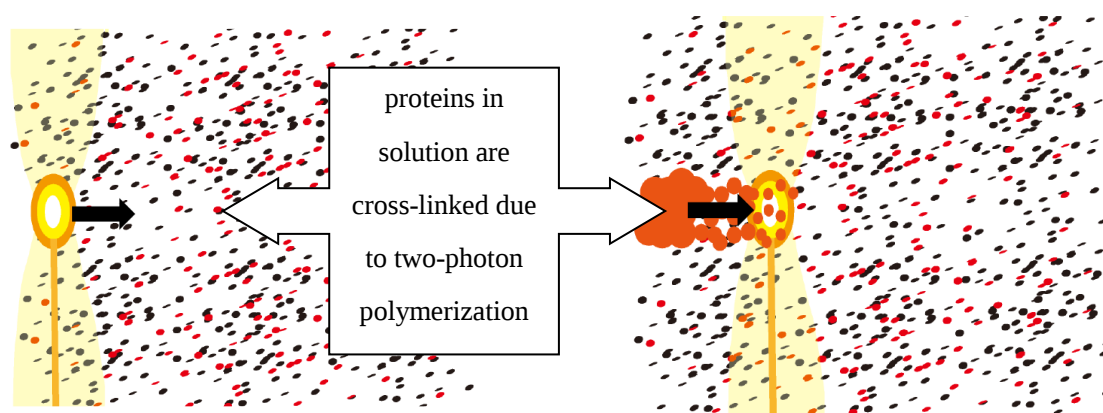


Figure 1 Laser Direct Writing of a Proteinaceous Wire. A fs-pulsed laser is focused into a pre-polymer solution of protein and photo-initiator/photosensitizer. A two-photon excitation leads to radical chain reaction and protein cross-linking. Movement of the laser focus through medium enables arbitrary design.

REFERENCES

- [1] J. D. Spikes, H.-R. Shen, P. Kopec'kov_a, and J. Kopec'ek, "Photodynamic crosslinking of proteins. III. Kinetics of the FMN- and rose Bengal-sensitized photooxidation and intermolecular crosslinking of model tyrosine-containing N-(2-hydroxypropyl)methacrylamide Co-polymers," *Photochem. Photobiol.* 70, 130–137 (1999).
- [2] L. Zhang, K. Zhang, R. Pr€andl, and F. Sch€offl, "Detecting DNA binding of proteins in vivo by UV crosslinking and immunoprecipitation," *Biochem. Biophys. Res. Commun.* 322, 705–711 (2004).
- [3] J. D. Pitts, P. J. Campagnola, G. A. Epling, and S. L. Goodman, "Submicron multiphoton free-form fabrication of proteins and polymers: Studies of reaction efficiencies and applications in sustained release," *Macromolecules* 33, 1514–1523 (2000).
- [4] D. Serien, and S. Takeuchi, "Fabrication of submicron proteinaceous structures by direct laser writing," *Applied Physics Letters* 107, 013702 (2015)
- [5] M. R. Lee, I. Y. Phang, Y. Cui, Y. H. Lee, and X. Y. Ling, "Shape-shifting 3D protein microstructures with programmable directionality via quantitative nanoscale stiffness modulation," *Small* 11, 740 (2015).