Laser direct writing of amino acid homo-polymers

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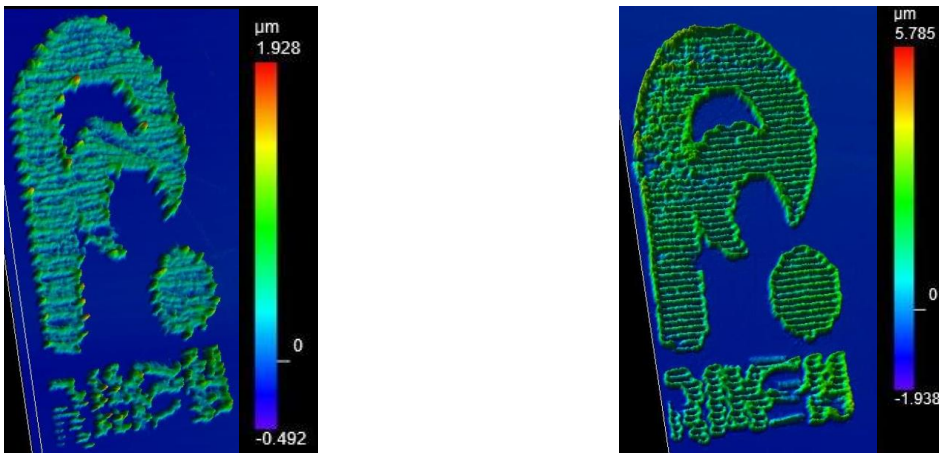
We have so far successfully demonstrated 3D printing of pure protein using femtosecond laser direct writing, while the cross-linking mechanism of protein molecules still leaves many questions to be discussed [1]. In this paper, we investigate laser direct writing of amino acid homo-polymers since protein is composed of amino acids. Amino acid homo-polymers are chain molecules in which one type of amino acid is repeatedly chemically linked to each other. We use a set of commercially available homo-polymers to investigate whether they can be processed similarly to protein precursors thus allowing us to draw conclusions regarding the mechanism of laser printing of protein.

Laser direct writing of protein is a 3D printing method to create protein microstructures [2]. We are interested in understanding the fabrication since protein can be used to provide complex biomimetic 3D microenvironment [2]. Due to the two-photon absorption, it is expected that the affected precursor material in volume becomes smaller than the focal volume [3]. Recently, we have provided evidence that chemical cross-linking by radical chain reactions enables to create pure proteinaceous microstructures using photoactivator-free, pure protein precursor [1].

Figure 1 shows structures representing RIKEN's logo fabricated from the protein bovine serum album (BSA) and from the three unit homo-polymer of tyrosine (Tyr-Tyr-Tyr) by femtosecond laser direct writing at comparable conditions. We apply FT-IR and Raman spectroscopy to analyze the structures fabricated using various homo-polymers, which enable us to illustrate which amino acids contribute to the cross-linking process of pure protein molecules. Protein engineering technologies then could be used to optimize target proteins and enhance their 3D printing accessibility.



(A) BSA **(B) TYR-TYR-TYR**

Figure 1: Confocal laser scanning 3D reconstruction of (A) bovine serum albumin (BSA) and (B) tyrosine homo-polymer with 3 units (Tyr-Tyr-Tyr). Both structures representing the RIKEN logo were fabricated with 2 mW average laser power and stage scanning speed of 5 µm/s on cover glass substrate. The fiber laser condition is 200 kHz, central wavelength of 524 nm and ca. 330 fs pulse width. A 20x objective lens with N.A.=0.46 was used. Lines are spaced 3 µm apart and the whole structure spans ca. 100x200 µm^2.

References

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