Characterization of DNA origami nanospace using G-quadruplex and i-motif structure as a molecular probe

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Physical properties of biomolecules such as thermal stability and folding kinetics change depending on the environment. For investigating the properties of biomolecules in a confined space, precise design of a nanoscale space to place the molecules is critical. We created a nano-sized space using DNA origami, and found that G-quadruplex placed in the nanospace was thermodynamically stabilized and folding occurred rapidly [1]. We investigated the influence of the nano-sized space on the physical properties of the i-motif (iM) and G-quadruplex (GQ) structure. Mechanical unfolding of the iM and GQ in the nanocages was performed using optical tweezers. The nanocages including iM and GQ were prepared by incorporation of iM- and GQ-containing strand into a half-opened nanocage and subsequent closing. In the nanocage, iM structure was formed stably even at a pH close to neutral [2]. By using four different sizes of nanocages, we found that the mechanical and thermodynamic stability of iM and GQ increased with decreasing size of nanocages. It was also found that the water activity reduced by decreasing the size of nanocages. These results revealed that the stability of iM and GQ in nanocages is correlated with the decrease in water activity.

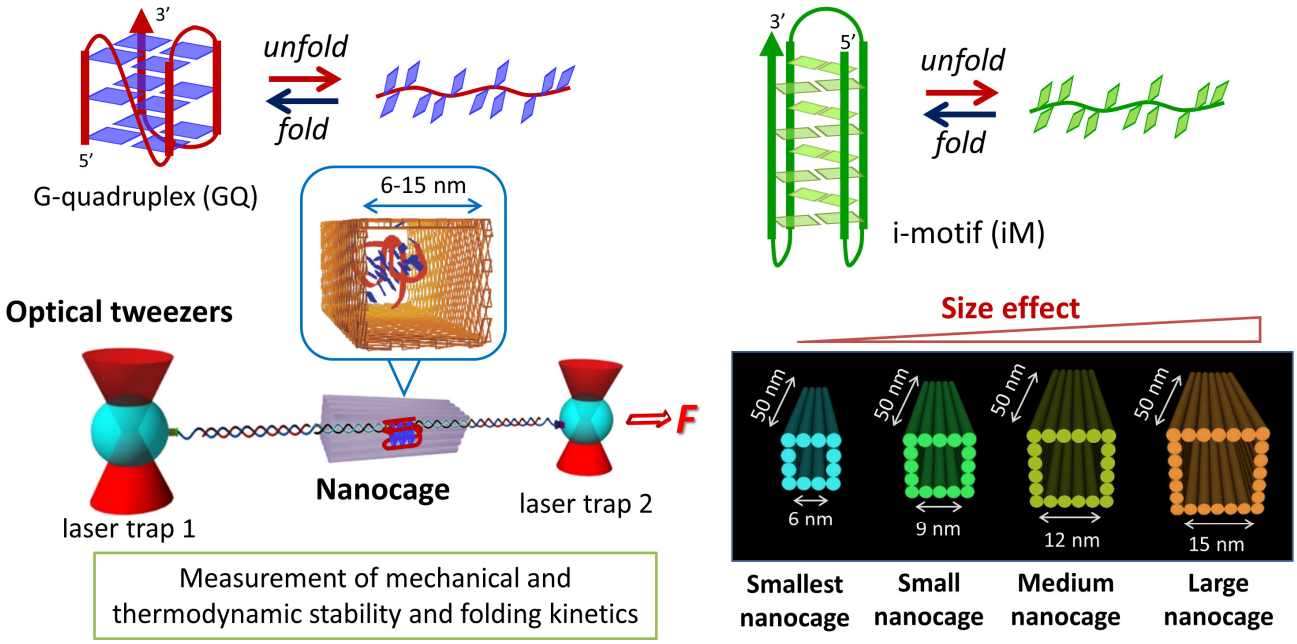

Figure 1: Schematic illustration of G-quadruplex (GQ) and i-motif (iM) in the DNA nanocage and the method to unfold and fold GQ and iM structure inside the four different sizes of nanocages using optical tweezers.

References

[1] P. Shrestha, M. Endo, H. Mao, *et al.*, *Nature Nanotechnology*, 2017, **12**, 582-588.
[2] S. Jonchhe, M. Endo, H. Mao, *et al.*, *Proc. Natl. Acad. Sci. USA*, 2018, **115**, 9539-9544.