

## **Physical Properties of metal-ion incorporated M-DNA**

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Although DeoxyriboNucleic Acid (DNA) is a well-known long polymer carrying a life-information, scientific and engineering interests have also directed to this intelligent polymer with a complementarity, designable sequence and possible electric and optical functions. The various reports on the electric properties of natural DNAs with nanotechnology have been reported with diverse conclusions. Thus, we started to unveil the intrinsic physical properties of DNA.

In this report, we demonstrate the possibility of charge injection to DNA by incorporation of divalent metal-ions: how to synthesize M-DNA (M is a metal), what is the structure, what is the magnetic property and what is the electronic states [1,2]. It has been confirmed that the metal ions locate in between the bases of a base pair and form 1-D chain in the B-form stable in lives, but 1-D spiral in the A-form in dry, where the magnetic phase below 0.4 K are observed. The location of metals could also be confirmed by STM with the flat-ladder form DNA stable on a HOPG surface. Furthermore, the bonding nature of metals with the bases is revealed to be highly ionic in Mn-DNA. Interestingly, only in the case of Fe-DNA the net charge transfer from Fe to DNA occurs, inducing the intra-gap states in optical absorption.

[1] K. Mizoguchi, et al, Phys. Rev. B 72, 033106 (2005).

[2] K. Mizoguchi, et al, J. Phys. Soc. Jpn. 76, 043801 (2007).