Bioinorganic Engineering: an Interface among Coordination Chemistry, Proteins, and Solid-state Materials

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Nature utilizes dinitrosyl iron unit [$Fe(NO)_2$] for the storage and transport of nitric oxide (NO), an ubiquitous gaseous signaling molecule in the biological system. Through biomimetic study, dinuclear dinitrosyl iron complexes (DNICs, [$Fe_2(\mu\text{-}SR)_2(NO)_4$]) were explored for controlled delivery of NO and translational biomedical applications. In particular, reversible interconversion between dinuclear [$Fe_2(\mu\text{-}S\ SCH_2CH_2OH)_2(NO)_4$] and mononuclear [$(NO)_2Fe(SCH_2CH_2OH)$(Protein-Cys)] enables the natural utilization of gastrointestinal mucin and serum albumin as endogenous vehicles for oral delivery of NO into brain and activation of hippocampal neurogenesis under neurodegenerative disorders. In this talk, conjugation of [$Fe_2(\mu\text{-}SCH_2CH_2COOH)_2(NO)_4$] (**DNIC-2**) with MIL-88B, a metal-organic framework (MOF) material, yielding a DNIC@MOF microrod will be discussed. Upon protonation of benezedicarboxylate (BDC) moiety under gastric acid condition, acid-induced transformation of DNIC@MOF results in the assembly of DNIC@tMOF, which is consisted of **DNIC-2** well-dispersed and protected within the BDC-based framework. Of importance, this discovery of transformer-like DNIC@MOF provides a parallel insight into its stepwise transformation into DNIC@tMOF in the stomach followed by subsequent conversion into molecular **DNIC-2** in the small intestine and release of NO in the blood stream of mice. In addition, conjugation of DNIC [$Fe_2(\mu\text{-S-thioglycerol})_2(NO)_4$] with MIL-88B-derived porous Fe_3O_4@C and encapsulation within thermo-responsive poly(lactic-co-glycolic acid) (PLGA) microsphere leads to the assembly of a magnetic-responsive nitric oxide-release material (MagNORM). Under continuous application of alternating magnetic field (AMF), burst release of nitric oxide from MagNORM triggers an effective anti-bacterial activity against both Gram-positive Staphylococcus aureus (*S. aureus*) and Gram-negative Escherichia coli (*E. coli*). In addition to the magneto-triggered bactericidal effect of MagNORM against *E. coli*-infected cutaneous wound in mice, steady release of nitric oxide from MagNORM without AMF promotes the subsequent collagen formation and wound healing in mice.