

## Abiotic Rapid Photocatalytic oxidation of Manganese by Fe oxides

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Considering the high redox reactivity and reduction potential, the Mn redox reaction is one of the important redox reactions in various energy fields such as energy catalysis and natural photosynthesis. While the importance of Mn redox reaction is well appreciated, fundamental understanding of Mn redox reaction remains elusive. For the oxidation of  $Mn^{2+}$  (aq), previous studies reported sluggish oxidation rates under abiotic conditions. Based on relatively much faster oxidation rates of  $Mn^{2+}$  (aq) in biotic processes, the contribution of abiotic oxidation of  $Mn^{2+}$  (aq) has been questioned. Strikingly, in this study, we show that oxidation of  $Mn^{2+}$  (aq) proceeds at a faster rate than the conventional oxidation process using a photocatalytic reaction with a natural Fe oxide mineral without microorganisms. Through the rapid photocatalytic oxidation of  $Mn^{2+}$  (aq), tunnel structured Mn oxide on Fe oxides occurs via heterogeneous nucleation. This study is environmentally friendly and may spark new interest in hitherto neglected abiotic processes for the fundamental redox mechanism of Mn in natural and engineered systems.