Size-dependent Photocatalytic Activity of Ligand-passivated Silicon Nanocrystals in Polar Solvent: Methyl Viologen Reduction

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In this study, we demonstrated photocatalysis by ligand-passivated Si nanocrystals in polar solvent and examined size-dependency of photocatalytic activity using methyl viologen (MV^{2+}). There has been several attempts investigating photocatalytic activity of H-terminated Si nanocrystals but we firstly report the photocatalysis of ligand-passivated Si nanocrystals. 10-undecenoic acid capped Si nanocrystals ranging from 2.7 to 8.4 nm showed photocatalytic activity in the presence of sodium sulfide (Na_2S) as hole scavenge. By achieving photocatalytic MV^{2+} reduction of which potential is almost same with that of hydrogen (H_2) generation using Si nanocrystals, we open the possibility that colloidal Si nanocrystals photocatalyst can be used for H_2 evolution from water. Size of Si nanocrystals influences the rate photocatalytic MV^{2+} reduction. The rate of reduction is really affected both by the light absorption of Si nanocrystals and the energy difference between the conduction band edge potential and the reduction potential of MV^{2+}. Therefore, to design a good photocatalyst, the optimization between these two factors have to be carefully considered.