Photocatalytic Generation of Solar Chemicals

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Photocatalysts as photo-functional materials are able to convert photo energy to chemical one, thus the property gives wide range applications for environmental cleaning and resource production, such as air and water purification, sterilization, hydrogen evolution, and photoelectrochemical conversion. In this presentation, photocatalytic production of bio-related chemicals are reported.

1) Production of rare sugars using photocatalysis. Rare sugars have much attention because of their potential candidates for new foods and drags. For example, D-allose has strong suppressive effect against cancer cell proliferation, and D-psicose shows much sweetness, high solubility, water-holding property, spreadability, resiliency and antioxidation. However, it is very hard to obtain those sugars, thus a common and facile new method to produce rare sugars is strongly requested. Our group recently reported that arabinose could be produced from the oxidative decomposition of glucose by titanium dioxide (TiO_2) photocatalysis under ultra-violet (UV) light illumination. In this work, we examined decomposition of monosaccharides to produce rare sugars by using the TiO_2 photocatalyst. Photocatalytic decomposition of galactose was performed with the TiO_2 photocatalyst under UV illumination, resulting in production of lyxose which is a rare sugar. From the comparison of molecular structure between garactose and lyxose, α-carbon was selectively released. We further performed photocatalytic oxidative decomposition of mannose, gulose, and allose, which allows production of arabinose, xylose and ribose, respectively. Those reaction also showed regular molecular conversion by release of α-carbon. Those results suggested that photocatalytic oxidative decomposition is able to produce rare sugars.

2) Spore inactivation with visible light responsive photocatalyst WO_3. Bacteria that cause serious food poisoning are known to sporulate under conditions of nutrient and water shortage. The resulting spores have much greater resistance to common sterilization methods, such as heating at 100 °C and exposure to various chemical agents. Since such bacteria cannot be inactivated with typical alcohol disinfectants, peroxyacetic acid (PAA) often is used, but PAA is a harmful agent that can seriously damage human health. Furthermore, concentrated hydrogen peroxide, which is also dangerous, must be used to prepare PAA. Thus, the development of a facile and safe sporicidal disinfectant is strongly required. In this study, we have developed an innovative sporicidal disinfection method that employs the combination of an aqueous ethanol solution, visible light irradiation, and a photocatalyst. We successfully produced a sporicidal disinfectant one hundred times as effective as commercially available PAA, while also resolving the hazards and odor problems associated with PAA.

References

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