i-Propylammonium lead chloride based perovskite photocatalysts for depolymerization of lignin under UV light

ABSTRACT

Lignin depolymerization for the purpose of synthesizing aromatic molecules is a growing focus of research to find alternative energy sources. In current studies, the photocatalytic depolymerization of lignin has been investigated by two new iso-propylamine-based lead chloride perovskite nanomaterials (SK9 and SK10), synthesized by the facile hydrothermal method. Characterization was done by Powder X-Ray Diffraction (PXRD), Scanning Electron Microscopy (SEM), UV-Visible (UV-Vis), Photoluminescence (PL), and Fourier-Transform Infrared (FTIR) Spectroscopy and was used for the photocatalytic depolymerization of lignin under UV light. Lignin depolymerization was monitored by taking absorption spectra and catalytic paths studied by applying kinetic models. The %depolymerization was calculated for factors such as catalyst dose variation, initial concentration of lignin, and varying temperatures. Pseudo-second order was the best suited kinetic model, exhibiting a mechanism for lignin depolymerization that was chemically rate controlled. The activation energy (Ea) for the depolymerization reaction was found to be 15 kJ/mol, which is remarkably less than conventional depolymerization of the lignin, i.e., 59.75 kJ/mol, exhibiting significant catalytic efficiencies of synthesized perovskites. Products of lignin depolymerization obtained after photocatalytic activity at room temperature (20 °C) and at 90 °C were characterized by GC-MS analysis, indicating an increase in catalytic lignin depolymerization structural subunits into small monomeric functionalities at higher temperatures. Specifically, 2-methoxy-4-methylphenol (39%), benzene (17%), phenol (10%) and catechol (7%) were detected by GC-MS analysis of lignin depolymerization products.

Keyword: Photocatalysis; Lignin depolymerization; Perovskites; Kinetics; Activation energy