Deoxygenation of waste sludge palm oil into hydrocarbon rich fuel over carbon-supported bimetallic tungsten-lanthanum catalyst

ABSTRACT

Activated carbon (AC) supported catalysts have been extensively applied as deoxygenation (DO) catalysts. However, the details of in situ experimental investigations that relevant to this catalyst are limited. Hereby, we present a series of operando/in situ spectroscopic experiments for DO of waste sludge palm oil (WSPO) by using atomically dispersed La-W bimetallic supported AC catalysts (La-W/AC) with well-defined structures. The La(5%)-W(2%)/AC catalyst prepared through co-precipitation (CP) process rendered high surface area (741 m2 /g) and catalyst's acidity (13319.16 µmol/g). Besides, the catalyst demonstrated a superior catalytic performance of DO reactivity under optimal reaction conditions of 0.5 % catalyst loading (CL), a one hour reaction time (Rt), and 250 ◦C reaction temperature (RT), achieving 98 % WSPO conversion to green fuel turnover frequency (TOF) of 0.0153 s-1. The reusability of La(5%)-W(2%)/AC catalyst was positively active for eight runs of DO process with constant of conversion rate at > 87 %. In addition, DO mechanism was of WSPO model compound (palmitic acid) was conducted to gain the clearer insight of reaction pathway catalysed by La-W/C catalyst. In situ FTIR analysis confirms the presence of intermediates (e.g. n-heptadecane, n-pentadecane, n-nonane, n-tridecane, and trimethylcyclopentene) that attributed buy the acid site of the heteropoly acid support. Besides, in situ XAS spectroscopy consolidates the oxidation state of La and W, where the presence of metal centre, support and substrate were confirmed to reflect the occurrence of palmitic acid DO on atomically dispersed La and W active sites. Thus, the present findings identified several key product intermediates during DO process, as well as the stable-state of catalyst structure, which suggest that the atomically dispersed La(5%)-W(2%)/AC catalysed reactions follow an unconventional decarboxylation/decarbonylation reaction pathways with the activation of oxygen (O2) removing is rate limiting.