The market demand for renewable fuels and chemicals has surged worldwide in the past decades. However, today the cost of liquid hydrocarbon fuels from biomass is still too high to compete with petroleum derived transportation fuels. One of the grand challenges in biofuels production is the low carbon atom efficiency to the fuel products. Herein our group has developed a novel “one-pot” biphasic tandem catalytic process (bTCP) in which terpenoids or lipids were converted into hydrocarbons at an extraordinarily high carbon efficiency. For demonstration, the mono- and diterpenoids, e.g., the biocrudes of eucalyptus and grindelia, were efficiently converted into cycloalkanes, a high-density jet fuel component. This bTCP process was also able to efficiently convert fatty acids and triglycerides extracted from oilseed crops to renewable diesel. Moreover, to improve the biorefinery economics, we have also been exploring conversion technologies for producing value-added chemicals. In this regard, we developed various liquid-phase catalytic processes for synthesizing a variety of chemicals from cellulosic biomass. In particular, we demonstrated that the oxidative function and the Lewis acidic property of the ZrO₂ and Zr-SBA15 materials in the liquid-phase solvents were attributed to the high-yield production of levulinic acid and ethyl lactate, respectively, from cellulose. Overall, the role of liquid-phase catalysis was investigated to gain a fundamental understanding of the effects of catalyst properties and process conditions on the conversion of various biomass feedstocks to renewable fuels and chemicals.

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