Highly Selective Catalyst Composition for Efficient Ethylene Oxide Production

Tech ID: 34013 / UC Case 2022-9A0-0

BACKGROUND

Ethylene oxide (EO) is a high-volume chemical used extensively to produce major chemicals and myriad consumer products. In 2020, the global production of EO reached 29 million metric tons, and the market is expected to grow. The epoxidation of ethylene by molecular oxygen to produce EO occurs ubiquitously over Ag based heterogeneous catalysts, and the best performance observed in patents and academic research approaches or just exceeds 90% selectivity to EO, CO_2 being the other, unwanted byproduct. This process has an uncommonly low single pass conversion in industrial chemistry and requires the reactants and products to be separated and recycled in an uncommonly large recycle stream into the entrance of the reactor to create a continuous process. The separation and recycle steps are extremely energy intensive, inspiring decades of efforts to efficiently improve EO selectivity and conversion. Because of the scale of this process, improving EO selectivity by even a few percent would represent a substantial improvement to the costs, energy usage, and CO_2 emissions involved in EO production.

DESCRIPTION

Researchers at UC Santa Barbara, Tufts University, and Tulane University have invented a heterogeneous catalyst formulation that has >90% selectivity toward EO formation from gas phase ethylene and oxygen, at high ethylene conversions up to 12%. This technology marks the first instance of Ni-doped Ag single-atom alloy nanoparticles, which are supported on inert alumina. Ni atoms dispersed in the Ag nanoparticles suppress the generation of unselective oxygen species (responsible for CO_2) leading to the formation of EO over the undesired product, carbon dioxide. The high selectivity at relatively a high conversion also suggests that the nature of the oxygen species on the NiAg catalyst mitigates the unwanted secondary reaction of EO combustion. Because catalysts are changed in EO-producing plants every 1-3 years, this catalyst has the potential to serve as a drop-in replacement for current catalyst technologies, creating an impactful operational advantage with minimal lead time to implementation. Furthermore, the catalyst has shown synergistic operation with conventional Cl promoters but has not been optimized with industrial supports or other common promoters (Cs, Re, Mo, etc.) suggesting room for further improvement in performance.

CONTACT

Donna M. Cyr
cyr@tia.ucsb.edu
tel: .

INVENTORS

- Christopher, Phillip
- Jalil, Anika

OTHER INFORMATION

KEYWORDS

ethylene oxide, ethylene, chemistry, industrial chemistry

CATEGORIZED AS

- **Materials & Chemicals**
  - Chemicals

RELATED CASES

2022-9A0-0

ADVANTAGES

- Achieves >90% selectivity toward EO formation from gas phase ethylene and oxygen, at high ethylene conversions up to 12%
- Simplifies implementation as a drop-in replacement for conventional catalysts
- Sets a course for further optimization with more reactor testing

APPLICATIONS

- Industrial Chemistry
- Ethylene Oxide (EO) production

PATENT STATUS

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Reference for National Filings	WO 2024/026176	02/01/2024	2022-9A0

Patent Pending

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Halide-Free Gas Phase Methanol Carbonylation for Environmentally Friendly Acetic Acid Production

University of California, Santa Barbara
Office of Technology & Industry Alliances
342 Lagoon Road, ,Santa Barbara,CA 93106-2055 |
https://www.tia.ucsb.edu
Tel: 805-893-2073 | Fax: 805.893.5236 | padilla@tia.ucsb.edu

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