CLAIMS

1. A process for producing propylene, the process comprising:

at least partially metathesizing a first composition comprising at least 10 wt.% butene to form a metathesis-reaction product, where the first composition is metathesized with a metathesis catalyst comprising a mesoporous silica catalyst impregnated with metal oxide, where the mesoporous silica catalyst includes a pore size distribution of 2.5 nm to 40 nm and a total pore volume of at least 0.600 cm^3/g;

at least partially cracking the metathesis-reaction product to form a cracking-reaction product comprising propylene, where the metathesis-reaction product is cracked with a cracking catalyst comprising a mordenite framework inverted (MFI) structured silica catalyst, where the MFI structured silica catalyst includes total acidity of 0.001 mmol/g to 0.1 mmol/g; and

at least partially separating propylene from the cracking-reaction product to form a product composition comprising at least 80 wt.% propylene.

2. The process of claim 1, where the MFI structured silica catalyst has a pore size distribution of at least 1.5 nm to 3 nm.

3. The process of claim 1, where the metal oxide of the mesoporous silica catalyst comprises one or more oxides of molybdenum, rhenium, tungsten, or combinations thereof.

4. The process of claim 1, where the metathesis and cracking occur in the same reactor.

5. The process of claim 1, where the metathesis occurs in a first reactor and the cracking occurs in a second reactor, the first reactor and second reactor arranged in series.

6. A process for producing propylene, the process comprising:

at least partially metathesizing a first composition comprising at least 10 wt.% butene to form a metathesis-reaction product, where the first composition is metathesized with a metathesis catalyst comprising an amorphous mesoporous silica foam impregnated with metal oxides, where the metathesis catalyst has a pore size distribution of at least 3 nm to 40 nm and a total pore volume of at least 0.700 cm^3/g;

at least partially cracking the metathesis-reaction product to form a cracking-reaction product comprising propylene, where the metathesis-reaction product is cracked with a cracking catalyst; and

at least partially separating propylene from the cracking-reaction product to form a product composition comprising at least 80 wt.% propylene.

7. The process of claim 6, where the metathesis catalyst further comprises tri-block copolymer structuring agent, where the tri-block copolymer structuring agent is poly(ethylene glycol)-block-poly(propylene glycol)-block-poly(ethylene glycol) structure.

8. The process of claim 6, where the pore size distribution is from at least 4 nm to 10 nm and the total pore volume is from at least 0.800 cm^3/g to 1.5 cm^3/g.

9. The process of claim 6, where the metathesis catalyst has a total acidity from 0.125 mmol/g to 0.500 mmol/g, and a surface area of 400 to 500 m^2/g.

10. A process for producing propylene, the process comprising:

introducing a first stream comprising butene to a reactor, where the reactor comprises a metathesis catalyst and a cracking catalyst, the metathesis catalyst positioned generally upstream of the cracking catalyst;

at least partially metathesizing the first stream with the metathesis catalyst to form a metathesis-reaction product;

at least partially cracking the metathesis-reaction product with the cracking catalyst to form a cracking-reaction product comprising butene;

passing the cracking-reaction product out of the reactor in a cracking-reaction product stream; and

at least partially separating propylene from the cracking-reaction product stream to form a product stream comprising propylene,

where:

at least a portion of the butene in the cracking-reaction product stream is recycled by at least partially separating butene in the cracking-reaction product stream to form a recycle stream comprising butene; and

the first stream is a mixture of the recycle stream and a system inlet stream.

11. The process of claim 10, where the system inlet stream comprises at least 50 wt.% butene.

12. The process of claim 10, where the product stream comprises at least 90 wt.% propylene.

13. The process of claim 10, where:

the metathesis catalyst comprises a mesoporous silica catalyst impregnated with metal oxide, where the mesoporous silica catalyst includes a pore size distribution of 2.5 nm to 40 nm and a total pore volume of at least 0.600 cm^3/g; and

the cracking catalyst comprises a mordenite framework inverted (MFI) structured silica catalyst downstream of the mesoporous silica catalyst, where the MFI structured silica catalyst includes total acidity of 0.001 mmol/g to 0.1 mmol/g.

14. A process for producing propylene, the process comprising:

introducing a first stream comprising butene to a first reactor, the first reactor comprising a metathesis catalyst;

at least partially metathesizing the first stream in the first reactor to form a metathesis-reaction product;

passing the metathesis-reaction product out of the first reactor in a metathesis-reaction product stream to a second reactor, the second reactor comprising a cracking catalyst;

at least partially cracking the metathesis-reaction product stream in the second reactor to form a cracking-reaction product;

passing the cracking-reaction product out of the second reactor in a cracking-reaction product stream comprising butene; and

at least partially separating propylene from the cracking-reaction product stream to form a product stream comprising propylene,

where:

at least a portion of the butene in the cracking-reaction product stream is recycled by at least partially separating butene from the cracking-reaction product stream to form a recycle stream comprising butene; and

the recycle stream is mixed with the metathesis-reaction product stream.

15. The process of claim 14, where:

the metathesis catalyst comprises a mesoporous silica catalyst impregnated with metal oxide, where the mesoporous silica catalyst includes a pore size distribution of 2.5 nm to 40 nm and a total pore volume of at least 0.600 cm^3/g; and

the cracking catalyst comprises a mordenite framework inverted (MFI) structured silica catalyst downstream of the mesoporous silica catalyst, where the MFI structured silica catalyst includes total acidity of 0.001 mmol/g to 0.1 mmol/g.