CLAIMS

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

isomerizing butene with an isomerization catalyst to form an isomerization reaction product, the isomerization catalyst comprising magnesium oxide (MgO);

metathesizing at least a portion of the isomerization reaction product with a metathesis catalyst to form a metathesis reaction product, the metathesis catalyst comprising a mesoporous silica catalyst support impregnated with metal oxide; and

cracking at least a portion of the metathesis reaction product with a cracking catalyst to form a cracking reaction product, the cracking reaction product comprising propene.

2. The process of claim 1, where:

the butene is isomerized and at least a portion of the isomerization reaction product is metathesized in a mixed isomerization and metathesis reaction zone to form the metathesis reaction product, the mixed isomerization and metathesis reaction zone comprising the MgO and the mesoporous silica catalyst support impregnated with metal oxide; and

the at least a portion of the metathesis reaction product is cracked in a cracking reaction zone downstream of the metathesis reaction zone, the cracking reaction zone comprising the cracking catalyst.

3. The process of claim 1, where:

the butene is isomerized in an isomerization reaction zone to form an isomerization reaction product, the isomerization reaction zone comprising the MgO; and

the at least a portion of the isomerization reaction product is at least partially metathesized and the at least a portion of the metathesis reaction product is cracked in a mixed metathesis and cracking reaction zone downstream of the isomerization reaction zone, the mixed metathesis and cracking reaction zone comprising the mesoporous silica catalyst support impregnated with metal oxide and the cracking catalyst.

4. The process of claim 1, where:

the butene is isomerized in an isomerization reaction zone to form the isomerization reaction product, the isomerization reaction zone comprising the MgO;

the at least a portion of the isomerization reaction product is metathesized in a metathesis reaction zone to form the metathesis reaction product, the metathesis reaction zone comprising the mesoporous silica catalyst support impregnated with metal oxide; and

the at least a portion of the metathesis reaction product is cracked in a cracking reaction zone to form a cracking reaction product, the cracking reaction zone comprising the cracking catalyst.

5. A process for producing propene, the process comprising:

introducing a stream comprising butene to an isomerization reaction zone comprising an isomerization catalyst, the isomerization catalyst comprising magnesium oxide (MgO);

isomerizing at least a portion of butane of the stream comprising butene in the isomerization reaction zone to form an isomerization reaction product stream;

passing the isomerization reaction product stream to a metathesis reaction zone comprising a metathesis catalyst, the metathesis catalyst comprising a mesoporous silica catalyst support impregnated with metal oxide;

metathesizing at least a portion of the isomerization reaction product stream with the metathesis catalyst to form a metathesis reaction product stream;

passing the metathesis reaction product stream to a cracking reaction zone comprising a cracking catalyst; and

cracking at least a portion of the metathesis reaction product stream with the cracking catalyst to form a cracking reaction product stream comprising propene.

6. The process of either of claims 4 or 5, where the metathesis reaction zone is positioned downstream of the isomerization reaction zone.

7. The process of any of claims 4-6, where the cracking reaction zone is positioned downstream of the metathesis reaction zone.

8. The process of any of claims 4-7, where the isomerization reaction zone, metathesis reaction zone, and the cracking reaction zone are disposed within a reactor.

9. The process of any of claims 4-8, where a volumetric ratio of the MgO in the isomerization reaction zone to the mesoporous silica catalyst support impregnated with metal oxide in the metathesis reaction zone is at least 1:2.

10. The process of any of claims 1-9, where the isomerization reaction, the metathesis reaction, and the cracking reaction are performed at a temperature of from 400 ℃ to 600 ℃.

11. The process of any of claims 1-10, where the isomerization reaction product comprises 1-butene and 2-butene.

12. The process of any of claims 1-11, where the MgO is pretreated in a calcination process at a calcination temperature of from 300 °C to 800 °C.

13. The process of any of claims 1-12, where the mesoporous silica catalyst support impregnated with metal oxide comprises from 1 weight percent to 30 weight percent tungsten oxide.

14. A multiple-stage catalyst system for producing propene, the multiple-stage catalyst system comprising an isomerization reaction zone, a metathesis reaction zone downstream of the isomerization reaction zone, and a cracking reaction zone downstream of the metathesis reaction zone, where:

the isomerization reaction zone comprises magnesium oxide (MgO);

the metathesis reaction zone comprises a mesoporous silica catalyst support impregnated with metal oxide; and

the cracking reaction zone comprises a zeolite catalyst, where the zeolite catalyst cracks the metathesis product stream to form a cracking product stream comprising propene.

15. The system of claim 14, where the isomerization reaction zone, the metathesis reaction zone, and the cracking reaction zone are disposed in one reactor.