(yield) and a high selectivity.

Solution to Problem

[0006]

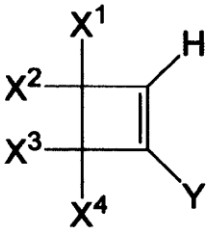
The present disclosure includes the following subject matter.

[0007]

Item 1.

~~In one aspect, there is provided a~~ A method for producing a cyclobutene represented by formula (1):

[0008]



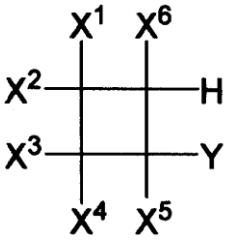
(1)

[0009]

wherein X^1, X^2, X^3, and X^4 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, and Y represents a halogen atom,

[0010]

the method comprising subjecting to an elimination reaction a cyclobutane represented by formula (2):



(2)

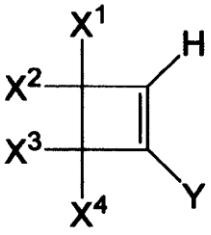
[0011]

wherein X^1, X^2, X^3, X^4, and Y are as defined above, X^5 and X^6 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group,

wherein the elimination reaction is performed in the presence of a base in a closed reaction system.

[0011a]

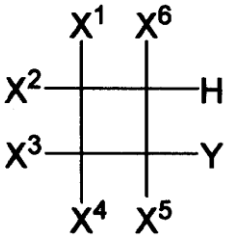
In one aspect, there is provided a method for producing a cyclobutene represented by formula (1):



(1)

wherein X^1, X^2, X^3, and X^4 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, and Y represents a halogen atom,

the method comprising subjecting to a dehydrohalogenation reaction a cyclobutane represented by formula (2):



(2)

wherein X^1, X^2, X^3, X^4, and Y are as defined above, X^5 represents a hydrogen atom, X^6 represents a hydrogen atom, wherein the dehydrohalogenation reaction is performed in the presence of a base in a closed reaction system, by using a catalyst:

wherein the catalyst for use is at least one hydrocarbon-based alkoxide selected from the group consisting of tetramethylammonium fluoride, tetramethylammonium chloride, tetramethylammonium bromide, tetramethylammonium iodide, tetraethylammonium fluoride, tetraethylammonium chloride, tetraethylammonium bromide, tetraethylammonium iodide, tetrapropylammonium fluoride,

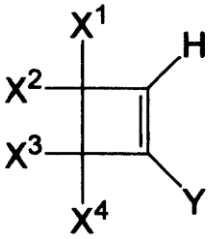
tetrapropylammonium chloride, tetrapropylammonium bromide, tetrapropylammonium iodide, tetrabutylammonium fluoride, tetrabutylammonium chloride, tetrabutylammonium bromide, tetrabutylammonium iodide, benzyltriethylammonium fluoride, benzyltriethylammonium chloride, benzyltriethylammonium bromide, benzyltriethylammonium iodide, benzyltributylammonium fluoride, benzyltributylammonium chloride, benzyltributylammonium bromide, benzyltributylammonium iodide, methyltributylammonium fluoride, methyltributylammonium chloride, methyltributylammonium bromide, methyltributylammonium iodide, methyltrioctylammonium fluoride, methyltrioctylammonium chloride, methyltrioctylammonium bromide, and methyltrioctylammonium iodide.

[0012]

Item 2.

~~In another aspect, there is provided a~~A method for producing a cyclobutene represented by formula (1):

[0013]



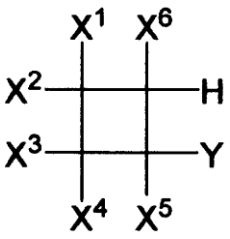
(1)

[0014]

wherein X^1, X^2, X^3, and X^4 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, and Y represents a halogen atom,

the method comprising subjecting to an elimination reaction a cyclobutane represented by formula (2):

[0015]



(2)

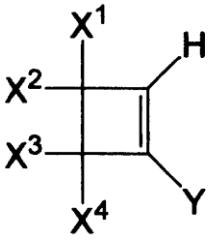
[0016]

wherein X^1, X^2, X^3, X^4, and Y are as defined above, and X^5 and X^6 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group,

wherein the elimination reaction is performed at a reaction temperature of 20°C or more under a reaction pressure of 0 kPa or more in the presence of a base.

[0016a]

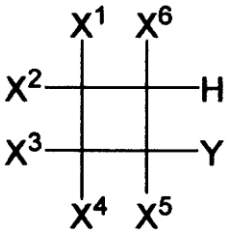
In another aspect, there is provided a method for producing a cyclobutene represented by formula (1):



(1)

wherein X^1, X^2, X^3, and X^4 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, and Y represents a halogen atom,

the method comprising subjecting to a dehydrohalogenation reaction a cyclobutane represented by formula (2):



(2)

wherein X^1, X^2, X^3, X^4, and Y are as defined above, and X^5 represents a hydrogen atom, and X^6 represents a hydrogen atom,

wherein the dehydrohalogenation reaction is performed at a reaction temperature of 20°C or more under a reaction pressure of 0 kPa or more in the presence of a base, by using a catalyst:

wherein the catalyst for use is at least one hydrocarbon-based alkoxide selected from the group consisting of tetramethylammonium fluoride, tetramethylammonium chloride, tetramethylammonium bromide, tetramethylammonium iodide, tetraethylammonium fluoride, tetraethylammonium chloride, tetraethylammonium bromide, tetraethylammonium iodide, tetrapropylammonium fluoride,

tetrapropylammonium chloride, tetrapropylammonium bromide, tetrapropylammonium iodide, tetrabutylammonium fluoride, tetrabutylammonium chloride, tetrabutylammonium bromide, tetrabutylammonium iodide, benzyltriethylammonium fluoride, benzyltriethylammonium chloride, benzyltriethylammonium bromide, benzyltriethylammonium iodide, benzyltributylammonium fluoride, benzyltributylammonium chloride, benzyltributylammonium bromide, benzyltributylammonium iodide, methyltributylammonium fluoride, methyltributylammonium chloride, methyltributylammonium bromide, methyltributylammonium iodide, methyltrioctylammonium fluoride, methyltrioctylammonium chloride, methyltrioctylammonium bromide, and methyltrioctylammonium iodide.

[0017]

Item 3.

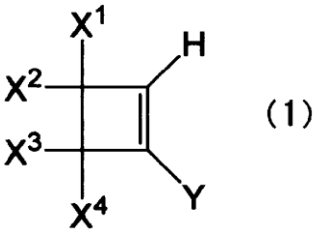
The method according to Item 1 or 2, wherein X^5 represents a hydrogen atom, X^6 represents a halogen atom, and the elimination reaction is a dehydrohalogenation reaction.

[0018]

Item 4.

~~In another aspect, there is provided a~~A composition comprising a cyclobutene represented by formula (1):

[0019]



(1)

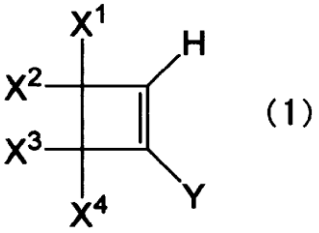
[0020]

wherein X^1, X^2, X^3, and X^4 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, and Y represents a halogen atom,

wherein the cyclobutene represented by formula (1) is present in an amount of 99 mol% or more based on the total amount of the composition taken as 100 mol%.

[0020a]

In another aspect, there is provided a composition comprising a cyclobutene represented by formula (1):



(1)

wherein X^1, X^2, X^3, and X^4 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, and Y represents a halogen atom,

wherein the cyclobutene represented by formula (1) is present in an amount of 99 mol% or more based on the total amount of the composition taken as 100 mol%,

wherein the composition comprises 1H-perfluorocyclobutene (1H-cC_4F_5H) and 3H-perfluorocyclobutene (3H-cC_4F_5H), the 1H-cC_4F_5H is present in an amount of 99 mol% or more, and the 3H-cC_4F_5H is present in an amount of 1 mol% or less, and

wherein the composition is for use in cleaning gas, etching gas, deposit gas, or a building block for organic synthesis.

[0021]

Item 5.

The composition according to Item 4, wherein 1H-perfluorocyclobutene (1H-cC_4F_5H) is present in an amount of 99 mol% or more, and 3H-perfluorocyclobutene (3H-cC_4F_5H) is present in an amount of 1 mol% or less.

[0022]

Item 6.

The composition according to Item 4 or 5, which is for use in cleaning gas, etching gas, deposit gas, or a building block for organic synthesis.

Advantageous Effects of Invention

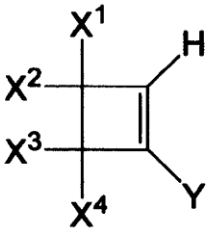
[0023]

The present disclosure enables the production of a halogen atom-containing cyclobutene at a high conversion rate (yield) and a high selectivity.

CLAIMS

[Claim 1]

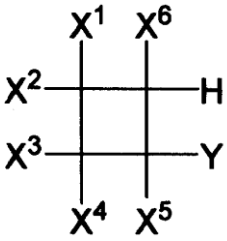
A method for producing a cyclobutene represented by formula (1):



(1)

wherein X^1, X^2, X^3, and X^4 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, and Y represents a halogen atom,

the method comprising subjecting to a~~n elimination~~ dehydrohalogenation reaction a cyclobutane represented by formula (2):



(2)

wherein X^1, X^2, X^3, X^4, and Y are as defined above, X^5 represents a hydrogen atom, ~~and~~ X^6 ~~are the same or different and~~ represents a hydrogen atom, ~~a halogen atom, or a perfluoroalkyl group,~~

wherein the dehydrohalogenation ~~elimination~~ reaction is performed in the presence of a base in a closed reaction system, by using a catalyst:

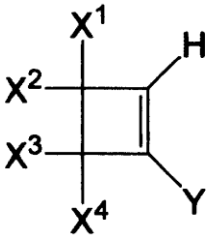
wherein the catalyst for use is at least one hydrocarbon-based alkoxide

selected from the group consisting of tetramethylammonium fluoride, tetramethylammonium chloride, tetramethylammonium

bromide, tetramethylammonium iodide, tetraethylammonium fluoride, tetraethylammonium chloride, tetraethylammonium bromide, tetraethylammonium iodide, tetrapropylammonium fluoride, tetrapropylammonium chloride, tetrapropylammonium bromide, tetrapropylammonium iodide, tetrabutylammonium fluoride, tetrabutylammonium chloride, tetrabutylammonium bromide, tetrabutylammonium iodide, benzyltriethylammonium fluoride, benzyltriethylammonium chloride, benzyltriethylammonium bromide, benzyltriethylammonium iodide, benzyltributylammonium fluoride, benzyltributylammonium chloride, benzyltributylammonium bromide, benzyltributylammonium iodide, methyltributylammonium fluoride, methyltributylammonium chloride, methyltributylammonium bromide, methyltributylammonium iodide, methyltrioctylammonium fluoride, methyltrioctylammonium chloride, methyltrioctylammonium bromide, and methyltrioctylammonium iodide.

[Claim 2]

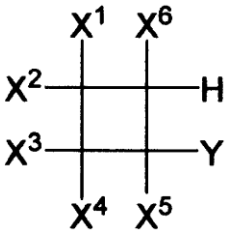
A method for producing a cyclobutene represented by formula (1):



(1)

wherein X^1, X^2, X^3, and X^4 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, and Y represents a halogen atom,

the method comprising subjecting to a~~n~~ dehydrohalogenation ~~elimination~~ reaction a cyclobutane represented by formula (2):



(2)

wherein X^1, X^2, X^3, X^4, and Y are as defined above, and X^5 represents a hydrogen atom, and X^6 ~~are the same or different and~~ represents a hydrogen atom, ~~a halogen atom, or a perfluoroalkyl group,~~

wherein the dehydrohalogenation ~~elimination~~ reaction is performed at a reaction temperature of 20°C or more under a reaction pressure of 0 kPa or more in the presence of a base, by using a catalyst:

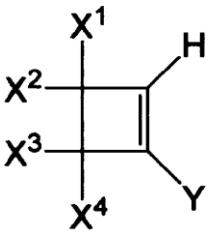
wherein the catalyst for use is at least one hydrocarbon-based alkoxide selected from the group consisting of tetramethylammonium fluoride, tetramethylammonium chloride, tetramethylammonium bromide, tetramethylammonium iodide, tetraethylammonium fluoride, tetraethylammonium chloride, tetraethylammonium bromide, tetraethylammonium iodide, tetrapropylammonium fluoride, tetrapropylammonium chloride, tetrapropylammonium bromide, tetrapropylammonium iodide, tetrabutylammonium fluoride, tetrabutylammonium chloride, tetrabutylammonium bromide, tetrabutylammonium iodide, benzyltriethylammonium fluoride, benzyltriethylammonium chloride, benzyltriethylammonium bromide, benzyltriethylammonium iodide, benzyltributylammonium fluoride, benzyltributylammonium chloride, benzyltributylammonium bromide, benzyltributylammonium iodide, methyltributylammonium fluoride, methyltributylammonium chloride, methyltributylammonium bromide, methyltributylammonium iodide, methyltrioctylammonium fluoride, methyltrioctylammonium chloride, methyltrioctylammonium bromide, and methyltrioctylammonium iodide.

~~[Claim 3]~~

~~The method according to claim 1 or 2, wherein X^5 represents a hydrogen atom, X^6 represents a halogen atom, and the elimination reaction is a dehydrohalogenation reaction.~~

[Claim ~~4~~3]

A composition comprising a cyclobutene represented by formula (1):



(1)

wherein X^1, X^2, X^3, and X^4 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, and Y represents a halogen atom,

wherein the cyclobutene represented by formula (1) is present in an amount of 99 mol% or more based on the total amount of the composition taken as 100 mol%,

wherein the composition comprises 1H-perfluorocyclobutene (1H-cC_4F_5H) and 3H-perfluorocyclobutene (3H-cC_4F_5H), the 1H-cC_4F_5H is present in an amount of 99 mol% or more, and the 3H-cC_4F_5H is present in an amount of 1 mol% or less, and

wherein the composition is for use in cleaning gas, etching gas, deposit gas, or a building block for organic synthesis.

~~[Claim 5]~~

~~The composition according to claim 4, wherein 1H-perfluorocyclobutene (1H-cC_4F_5H) is present in an amount of 99 mol% or more, and 3H-perfluorocyclobutene (3H-cC_4F_5H) is present in an amount of 1 mol% or less.~~

~~[Claim 6]~~

~~The composition according to claim 4 or 5, which is for~~

~~use in cleaning gas, etching gas, deposit gas, or a building block for organic synthesis.~~