DESCRIPTION

Title of Invention: METHOD FOR PRODUCING CYCLOBUTANE

Technical Field

[0001]

The present disclosure relates to a method for producing cyclobutane.

Background Art

[0002]

Cyclobutanes that contain halogen atoms are useful compounds, for example, in various refrigerants, foaming agents, and heat transfer mediums, as well as dry etching gas for semiconductors.

[0003]

NPL 1 discloses a method for producing 1H-heptafluorocyclobutane from 3,3,4,4,-tetrafluorocyclobutene by performing a fluorination reaction by using a fluorinating agent such as CoF_3 , MnF_3 , AgF_2 , CeF_4, or $KCoF_4$.

[0004]

NPL 2 discloses a method for producing 1Br,2H-hexafluorocyclobutane (cC_4F_6BrH) from hexafluorocyclobutene (cC_4F_6) by performing an addition reaction by using hydrogen bromide (HBr).

Citation List

Non-patent Literature

[0005]

NPL 1: Journal of Fluorine Chemistry, 2006, Vol. 127, 79-84, Fluorination of fluoro-cyclobutene with high-valency metal fluoride

NPL 2: Journal of American Chemistry, 1949, Vol. 71, 2339-2340, The Addition of Hydrogen Bromide to Fluorinated Olefins

Summary

[0013]

Item 2.

The method according to Item 1, wherein 0.1 mol to 100 mol of the hydrogen fluoride is supplied per mol of the cyclobutene represented by formula (2) to perform the reaction.

[0014]

Item 3.

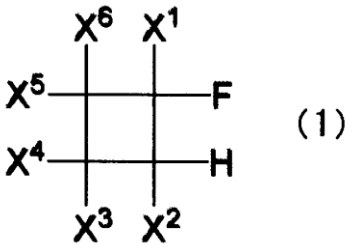
The method according to Item 1 or 2, wherein the catalyst is at least one member selected from the group consisting of activated carbon and chromium compounds.

[0015]

Item 4.

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

[0016]



(1)

[0017]

wherein X^1, X^2, X^3, X^4, X^5, and X^6 are the same or different and represent a hydrogen atom, a halogen atom, or a perfluoroalkyl group, wherein the cyclobutane 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%.

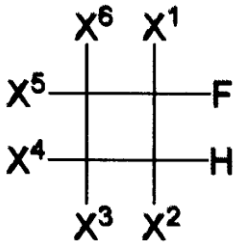
[0018]

Item 5.

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

[0018a]

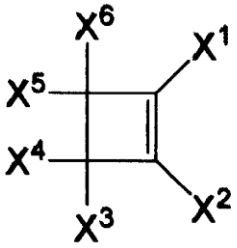
In one aspect, there is provided a method for producing a cyclobutane represented by formula (1):



(1)

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

the method comprising reacting a cyclobutene represented by formula (2):



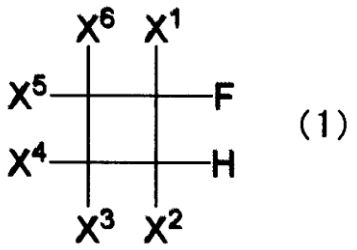
(2)

wherein X^1, X^2, X^3, X^4, X^5, and X^6 are as defined above with hydrogen fluoride in the presence of a catalyst in a gas phase,

wherein the reaction is an addition reaction of hydrogen fluoride.

[0018b]

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



(1)

wherein X^1, X^2, X^3, X^4, X^5, and X^6 are the same or different and represent a fluorine atom or a perfluoroalkyl group,

wherein the cyclobutane 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%, and

wherein the composition is for use in cleaning gas or etching gas.

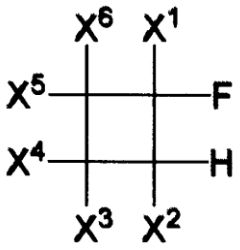
Advantageous Effects of Invention

[0019]

CLAIMS

[Claim 1]

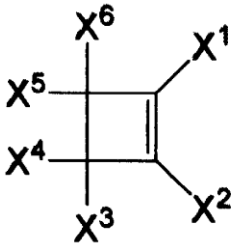
A method for producing a cyclobutane represented by formula (1):



(1)

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

the method comprising reacting a cyclobutene represented by formula (2):



(2)

wherein X^1, X^2, X^3, X^4, X^5, and X^6 are as defined above with hydrogen fluoride in the presence of a catalyst in a gas phase,

wherein the reaction is an addition reaction of hydrogen fluoride.

[Claim 2]

The method according to claim 1, wherein 0.1 mol to 100 mol of the hydrogen fluoride is supplied per mol of the cyclobutene represented by formula (2) to perform the reaction.

[Claim 3]

The method according to claim 1 or 2, wherein the catalyst is supported on a carrier selected from carbon, alumina, zirconia, silica, and titania,

where the carbon is selected from the group consisting of activated carbon, amorphous carbon, graphite, and diamond.

[Claim 4]

The method according to any one of claims 1 to 3, wherein the catalyst is at least one member selected from the group consisting of:

activated carbon;

chromium catalyst selected from the group consisting of chromium oxide, fluorinated chromium oxide, and chromium fluoride;

aluminum catalyst selected from the group consisting of aluminum oxide, fluorinated aluminum oxide, and aluminum fluoride;

iron catalyst selected from the group consisting of iron oxide, fluorinated iron oxide, and iron fluoride;

nickel catalyst selected from the group consisting of nickel oxide, fluorinated nickel oxide, and nickel fluoride; and

magnesium catalyst selected from the group consisting of magnesium oxide, fluorinated magnesium oxide, and magnesium fluoride,

provided that the combination, where the carrier is activated carbon when the catalyst is activated carbon, is excluded.

[Claim 5]

The method according to any one of claims 1 to 3, wherein the catalyst is at least one member selected from the group consisting of:

activated carbon; and

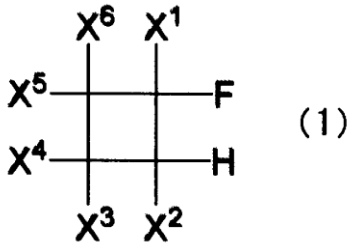
chromium catalyst selected from the group consisting of

chromium oxide, fluorinated chromium oxide, and chromium fluoride;

provided that the combination, where the carrier is activated carbon when the catalyst is activated carbon, is excluded.

[Claim 6]

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



(1)

wherein X^1, X^2, X^3, X^4, X^5, and X^6 are the same or different and represent a fluorine atom or a perfluoroalkyl group,

wherein the cyclobutane 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%, and

wherein the composition is for use in cleaning gas or etching gas.

[Claim 7]

The composition according to claim 6,

wherein the cyclobutane represented by formula (1) is a fluorine atom-containing cyclobutane selected from the group consisting of

