# MOLECULAR SIEVE SSZ-96 COMPOSITION OF MATTER AND SYNTHESIS THEREOF

## TECHNICAL FIELD

[001] The present disclosure relates to new crystalline molecular sieve SSZ-96, a method for preparing SSZ-96 using a 1-butyl-1-methyl-octahydroindolium cation as a structure directing agent ("SDA") and uses for SSZ-96.

## BACKGROUND

[002] Because of their unique sieving characteristics, as well as their catalytic properties, crystalline molecular sieves and zeolites are especially useful in applications such as hydrocarbon conversion, gas drying and separation. Although many different crystalline molecular sieves have been disclosed, there is a continuing need for new molecular sieves with desirable properties for gas separation and drying, hydrocarbon and chemical conversions, and other applications. New molecular sieves may contain novel internal pore architectures, providing enhanced selectivities in these processes.

## SUMMARY

[003] The present disclosure is directed to a family of crystalline molecular sieves with unique properties, referred to herein as "molecular sieve SSZ-96" or simply "SSZ-96."

[004] In one aspect, there is provided a molecular sieve having a mole ratio of at least 10 of (1) silicon oxide to (2) aluminum oxide, and having, in its calcined form, an X-ray diffraction pattern as shown in the following Table:

| 2-Theta | d-spacing (nm) | Relative Intensity |
|---|---|---|
| 7.50 ± 0.20 | 1.178 | VS |
| 8.52 ± 0.20 | 1.037 | M |
| 14.50 ± 0.20 | 0.610 | W |
| 20.86 ± 0.20 | 0.425 | S |
| 22.26 ± 0.20 | 0.399 | VS |
| 22.76 ± 0.20 | 0.390 | S |
| 23.60 ± 0.20 | 0.377 | W |
| 24.02 ± 0.20 | 0.370 | W |

| | | |
|---|---|---|
| 25.16 ± 0.20 | 0.354 | W |
| 26.40 ± 0.20 | 0.337 | W |
| 26.94 ± 0.20 | 0.331 | W |
| 28.57 ± 0.20 | 0.312 | W |
| 29.41 ± 0.20 | 0.303 | W |

[004a] In one aspect, there is provided a method for synthesizing a molecular sieve comprising contacting under crystallization conditions: (1) at least one source of silicon oxide; (2) one or more sources of aluminum oxide; (3) at least one source of an element (M) selected from Groups 1 and 2 of the Periodic Table; (4) hydroxide ions; and (5) a 1-butyl-1-methyl-octahydroindolium cation (Q),

wherein the molecular sieve has, in its calcined form, an X-ray diffraction pattern as shown in the following Table:

| 2-Theta | d-spacing (nm) | Relative Intensity |
|---|---|---|
| 7.50 ± 0.20 | 1.178 | VS |
| 8.52 ± 0.20 | 1.037 | M |
| 14.50 ± 0.20 | 0.610 | W |
| 20.86 ± 0.20 | 0.425 | S |
| 22.26 ± 0.20 | 0.399 | VS |
| 22.76 ± 0.20 | 0.390 | S |
| 23.60 ± 0.20 | 0.377 | W |
| 24.02 ± 0.20 | 0.370 | W |
| 25.16 ± 0.20 | 0.354 | W |
| 26.40 ± 0.20 | 0.337 | W |
| 26.94 ± 0.20 | 0.331 | W |
| 28.57 ± 0.20 | 0.312 | W |
| 29.41 ± 0.20 | 0.303 | W |

wherein the molecular sieve is prepared from a reaction mixture comprising, in terms of mole ratios, the following:

| | |
|---|---|
| $SiO_2/Al_2O_3$ | ≥ 10 |
| $M/SiO_2$ | 0.01 to 1.0 |
| $Q/SiO_2$ | 0.05 to 0.5 |
| $OH/SiO_2$ | 0.1 to 1.0 |
| $H_2O/SiO_2$ | 10 to 100 |

and the crystallization conditions include a temperature between 125°C and 200°C.

## CLAIMS

1. A molecular sieve having a mole ratio of at least 10 of (1) silicon oxide to (2) aluminum oxide, and having, in its calcined form, an X-ray diffraction pattern as shown in the following Table:

| 2-Theta | d-spacing (nm) | Relative Intensity |
|---|---|---|
| 7.50 ± 0.20 | 1.178 | VS |
| 8.52 ± 0.20 | 1.037 | M |
| 14.50 ± 0.20 | 0.610 | W |
| 20.86 ± 0.20 | 0.425 | S |
| 22.26 ± 0.20 | 0.399 | VS |
| 22.76 ± 0.20 | 0.390 | S |
| 23.60 ± 0.20 | 0.377 | W |
| 24.02 ± 0.20 | 0.370 | W |
| 25.16 ± 0.20 | 0.354 | W |
| 26.40 ± 0.20 | 0.337 | W |
| 26.94 ± 0.20 | 0.331 | W |
| 28.57 ± 0.20 | 0.312 | W |
| 29.41 ± 0.20 | 0.303 | W |

2. The molecular sieve of claim 1, wherein the molecular sieve has a composition, as-synthesized and in its anhydrous state, in terms of mole ratios, as follows:

| | |
|---|---|
| $TO_2/X_2O_n$ | $\geq 10$ |
| $Q/TO_2$ | 0.05 to 0.5 |
| $M/TO_2$ | 0.01 to 0.6 |

wherein:

(1) T is Si;

(2) X is Al;

(3) *n* equals the valence state of X;

(4) Q is a 1-butyl-1-methyl-octahydroindolium cation; and

(5) M is selected from the group consisting of elements from Groups 1 and 2 of the Periodic Table.

3. A method for synthesizing a molecular sieve comprising contacting under crystallization conditions: (1) at least one source of silicon oxide; (2) one or more sources of aluminum oxide; (3) at least one source of an element (M) selected from Groups 1 and 2 of the Periodic Table; (4) hydroxide ions; and (5) a 1-butyl-1-methyl-octahydroindolium cation (Q),
wherein the molecular sieve has, in its calcined form, an X-ray diffraction pattern as shown in the following Table:

| 2-Theta | d-spacing (nm) | Relative Intensity |
|---|---|---|
| 7.50 ± 0.20 | 1.178 | VS |
| 8.52 ± 0.20 | 1.037 | M |
| 14.50 ± 0.20 | 0.610 | W |
| 20.86 ± 0.20 | 0.425 | S |
| 22.26 ± 0.20 | 0.399 | VS |
| 22.76 ± 0.20 | 0.390 | S |
| 23.60 ± 0.20 | 0.377 | W |
| 24.02 ± 0.20 | 0.370 | W |
| 25.16 ± 0.20 | 0.354 | W |
| 26.40 ± 0.20 | 0.337 | W |
| 26.94 ± 0.20 | 0.331 | W |
| 28.57 ± 0.20 | 0.312 | W |
| 29.41 ± 0.20 | 0.303 | W |

wherein the molecular sieve is prepared from a reaction mixture comprising, in terms of mole ratios, the following:

| | |
|---|---|
| $SiO_2/Al_2O_3$ | ≥ 10 |

| | |
|---|---|
| $M/SiO_2$ | 0.01 to 1.0 |
| $Q/SiO_2$ | 0.05 to 0.5 |
| $OH/SiO_2$ | 0.1 to 1.0 |
| $H_2O/SiO_2$ | 10 to 100 |

and the crystallization conditions include a temperature between 125°C and 200°C.

4. The method of claim 3, wherein the molecular sieve is prepared from a reaction mixture comprising, in terms of mole ratios, the following:

| | |
|---|---|
| $TO_2/X_2O_n$ | 20 to 100 |
| $M/TO_2$ | 0.02 to 0.35 |
| $Q/TO_2$ | 0.1 to 0.3 |
| $OH/TO_2$ | 0.2 to 0.6 |
| $H_2O/TO_2$ | 20 to 50. |