NEW POWDER MATERIAL
Nano-sized Zeolite

SiC powder
Nano-sized Zeolite

Sample Spec

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Type (cation)</th>
<th>Pore Diameter (Å)</th>
<th>Average Particle Size (nm)</th>
<th>Sample Amount (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z4A-005-R</td>
<td>4A(Na)</td>
<td>4</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Z4A-005-L</td>
<td>4A(Na)</td>
<td>4</td>
<td>50</td>
<td>500</td>
</tr>
<tr>
<td>Z4A-030-R</td>
<td>4A(Na)</td>
<td>4</td>
<td>300</td>
<td>100</td>
</tr>
<tr>
<td>Z4A-030-L</td>
<td>4A(Na)</td>
<td>4</td>
<td>300</td>
<td>500</td>
</tr>
</tbody>
</table>

SiC powder

Please let us know your requirements.

Nakamura Choukou Co., Ltd.

27-27, Tsuruta-cho, Nishi-ku, Sakai City, Osaka 593-8323

Phone: (+81)72-274-0777 (reception)

E-mail: zeolite-eigyo@nakamura-gp.co.jp
Company Outline

Main Office Address: 27-27, Tsuruta-cho, Nishi-ku, Sakai City, Osaka 593-8323
Establishment: December 21, 1970
Representative: Makoto Inoue, President
Capital: 2,000,122,800 yen
Number of employees: 257 (consolidated), 170 (non-consolidated) (as of December 31, 2015)
Affiliated companies: Nippon Nozzle Co., Ltd. (100% ownership of share capital)
Suminoe Nakacho Device Technology Corporation (49.9% ownership of share capital)

Company History

October 1954: Established Nakamura Steel Works in Asahigaoka Kita-machi, Sakai-ku, Sakai City, Osaka for production and distribution of ultra-hard jigs and tools.
December 1970: Established Nakamura Choukou Co., Ltd..
July 1989: Newly established Main Office Factory at, and moved the Main Office to Otori Minami-machi, Nishi-ku, Sakai City, Osaka.
June 2001: Newly established “MAC Center” at Tsuruta-cho, Nishi-ku, Sakai City, Osaka. (Currently, Main Office)
November 2005: Newly established “MAC Center, South Building”.
April 2008: Acquired all shares of Nippon Nozzle, Co., Ltd. and made it a wholly-owned subsidiary. (Currently, consolidated subsidiary)
January 2010: Newly established “Izumi Factory 1, Building 1” at Ayumino, Izumi-City, Osaka.
February 2010: Started mass production of silicon wafers for solar cells.
June 2010: Closed Main Office Factory (Otori Minami-machi) and moved the Main Office to “MAC Center” (Tsuruta-cho, Nishi-ku, Sakai City).
September 2010: Newly established “Izumi Factory 1, Building 2” at Ayumino, Izumi City, Osaka. Started distribution of diamond saw wires.
January 2011: Increase the capital to 1,301,875,000 yen. (Received 1,245,000,000 yen of investment from “Innovation Network Corporation of Japan,” a public-private investment fund).
June 2011: Newly established “Izumi Factory 1, Building 3” at Ayumino, Izumi City, Osaka.
February 2013: Established “Shanghai Nakamura Choukou Trading Co., Ltd., a Chinese subsidiary, in Shanghai City, China. (Currently, consolidated subsidiary).
September 2013: Transferred the silicon wafer slicing business for solar cells to Suminoe Nakacho Device Technology Corporation, joint venture established by Suminoe Textile Company Ltd. and us (Currently, Equity method applicable affiliated company).
June 2015: Got the shares listed on the Tokyo Exchanges, Market of the High-Growth and Emerging Stocks (Mothers) (Securities Identification Code: 6166)
December 2015: Opened “Izumi Factory 2” at Ayumino, Izumi City, Osaka.
Nakamura Choukou Co., Ltd., in collaboration with Tokyo University, developed an innovative production process for zeolite nano-particles by utilizing the **crushing and recrystallizing** technology held by the University, and succeeded in production of low-cost nano-sized zeolite powder. While maintaining zeolite's inherent functions such as adsorption, this technology allows to minimize the particle size to **50 - 300 nm**. By minimizing the particle size to an unnoticeable level by human five senses, this technology does not damage the basic properties and esthetics of the target objects to which the function is added. The technology opens the door to possibilities widely, for example, optical application which requires light transparency, and addition to tiny fibers.

**Realized practical-level production cost**

**Crushing and Recrystallizing Process**

**Conventional product method**
- (Bottom-up)
- Ex. • Synthesis in diluted aluminosilicate solution
  • Use of organic substances, such as structure directing agents
  - Silicon source
  - Aluminum source
  - Mineralizer
  - Water
  - Structure directing agent

**New Method**
- (Top-down)
- Hydrothermal synthesis method
  - Heating/Compression

**Use of technological seeds of Tokyo University**

Production method of fine zeolite (Toru Wakahara, Nakamura Choukou Co., Ltd.)

Nano-sized zeolite

Nano-sizing
- UP Ion exchange property
- UP Catalyst property
- UP Outer surface area
- UP Dispersion in pores
- UP Adsorption property

*Under application for trademark registration*
Particle size: FE-SEM 50 - 300 nm

- Ordinary zeolite
- Zeolal 4A Type 50 nm-product
- Zeolal 4A Type 300 nm-product

- Fine and homogeneous nano-particles
  *The average particle sizes are not guarantee values.

Vapor Adsorption/Desorption Isotherm

- Large pore adsorption amount
- Large outer surface area

Water adsorption amount (g_{H_2O}/g_{zeolite})

<table>
<thead>
<tr>
<th></th>
<th>Micro-sized zeolite</th>
<th>Developed nano-sized zeolite</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH (50)</td>
<td>0.26</td>
<td>0.28</td>
</tr>
<tr>
<td>RH (90)</td>
<td>0.27</td>
<td>0.35</td>
</tr>
</tbody>
</table>

*The water adsorption amounts are not guarantee values.

Crystallinity: XRD Pattern

- A-Type Zeolite Phase

- Developed nano-sized zeolite
- Micro-sized zeolite

- Peak area 11500
- Peak area 11600

- Particle size FE-SEM: 50 - 300 nm
- Number frequency / %
- Particle size / nm
- Intensity (a.u.)
- 2θ (degree)

- Image 87x602 to 210x694
- Image 233x601 to 358x694
- Image 381x601 to 505x694
Effective Use of Silicon Sludge

Appearance

- Green color unique to GC
- Sharp shape
- Rounded fine particles

SEM

- Ordinary SiC/Crushing method
- Developed Si/C/Bottom-up method

Crystalline Phase

- β-SiC monophase

XRD Pattern

- Generation of a large amount of good-quality silicon sludge

Particle Size Distribution

- (d50) 0.33
- (d50) 6.3

Development to diverse applications

- Please let us know your requirements.