

Aerogel for EIC

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Dec. 5, 2022

Key Choices on Production Techniques

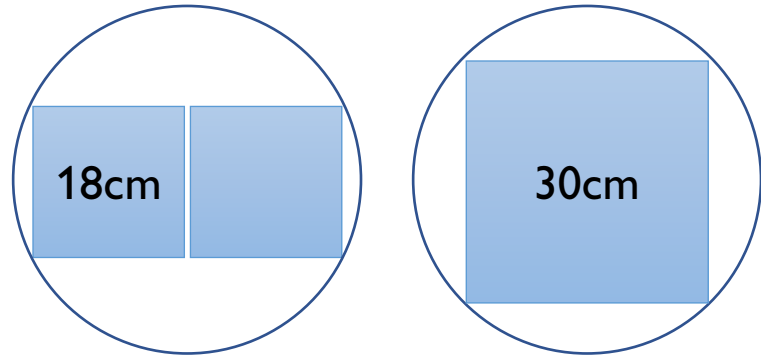
- Mold design
 - Ready-made PS mold for prototyping studies
 - Custom-ordered PS (or other material) mold for actual mass production
- Wet-gel synthesis
 - Chemical recipe for index control and transparency maximization
- Aging (and hydrophobic treatment)
 - Temperature and time (days) for index control (reproducibility)
- Supercritical drying
 - High- or low-temperature methods

Wet-Gel Drying—Two Methods

- **High-temperature** supercritical drying (HT-SCD)
 - Using **alcohol**.
 - **Russian** researchers use HT-SCD (as far as I know).
 - AF has a HT-SCD device with a nominal capacity of **20 tiles** with **15cm x 15cm x 2cm**.
- **Low temperature** supercritical drying (LT-SCD)
 - Using liquified **carbon dioxide**.
 - **Belle-II**'s aerogel was manufactured with LT-SCD.
 - AF has a small LT-SCD device for testing. with a nominal capacity of **10 tiles** with **11cm x 11cm x 2cm**.
 - Availability of a third-party's LT-SCD device in Japan; the connection between KEK/ChibaU and a company was ended after Belle-II's aerogel production. I am trying to reconnect with the company.

LT-SCD

- Belle-II aerogel size (18cm x 18cm) was designed so that two tiles can be stored per shelf.
- With 15 shelves, a total of 30 tiles can be dried at once.
- In terms of the shelf size, a tile size of ~30cm x 30cm will be possible.

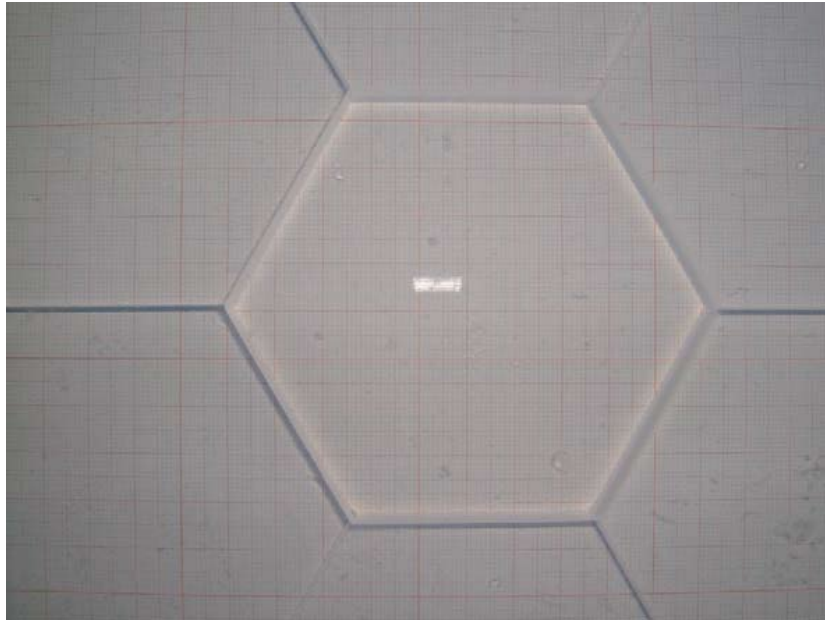


Key Properties

- Refractive index: Wet-gel synthesis, aging and SCD
- Transparency: Wet-gel synthesis, aging and SCD
- Tile size (and thickness): Mold design and SCD
- Tile integrity
 - Surface planarity: Mold design, wet-gel synthesis and SCD
 - No cracking: SCD
 - No bubbles: Wet-gel synthesis

Honeycomb Structure?

- A sample: Water-jet-machined hexagonal blocks from square tiles. Simply put blocks side-by-side with no optical contact.



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Nuclear Instruments and Methods in Physics Research A 553 (2005) 146–151

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Study of highly transparent silica aerogel as a RICH radiator

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Table

| | dRICH | mRICH | Prox.focusRICH | |
|----------------|----------------|--|----------------|--|
| Index | 1.015–1.025 | ~1.03 | | |
| Size | 20 x 20 x 2 cm | 10 x 10 x 4 cm | | |
| # of tiles | > 300 tiles | > 100 tiles | | |
| Absorp. coeff. | > 0.95 | | | |
| Scatt. length | > 45 mm | | | |
| (Prototyping) | | | | |
| Size | 5 x 5 x 2 cm | 10 x 10 x 3 cm 10 x 10 x 4 cm 10 x 10 x 5 cm | | |
| # of tiles | > 20 tiles | 3 tiles each | | |
| Size | 20 x 20 x 2 cm | | | |
| # of tiles | > 10 tiles | | | |

Company

| Production process | (options) | Company (in Japan) | Comments |
|----------------------|--------------------------------|----------------------|--|
| Wet-gel synthesis | | Aerogel Factory (AF) | |
| Supercritical drying | | | |
| | High temperature Method (30 L) | Aerogel Factory | Capacity: 15x15x2cm, 20tiles LEPS2 mass production |
| | Low temperature method (8 L) | Aerogel Factory | Capacity: 11x11x2cm, 10tiles Mainly for R&D |
| | Low temperature method (140 L) | Company A | Capacity: 18x18x2cm, 30tiles (Max. ~30x30x2cm, 15tiles) Connection with AF to be established soon. |
| Water-jet cutting | | Company B | Active connection with AF |

Refractive Index and Scattering Length

- Any index is possible.
- In terms of transparency (scattering length):
 - $n=1.05$: almost optimized by R&D for Belle II (40 mm)
 - $n=1.04$: improved recently (50–55 mm)
 - $n=1.03$: almost optimized by R&D for LEPS2 (60–65 mm)
 - $n=1.025$: need small R&D (55 mm to be expected)
 - $n=1.02$: need R&D (now 40 mm, 45 mm to be expected)
 - $n=1.015$: need R&D (now 20–25 mm, 30–35 mm to be expected)
- Tile to tile variation.
 - Experience in Belle II: ± 0.002 at $n=1.05$ ($\pm 4\%$).
 - Experience in LEPS2: ± 0.0005 at $n=1.03$ ($\pm 1.7\%$).

