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Assembly of a Silica Aerogel Radiator Module for the Belle II ARICH System

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We have been in the process of developing the ARICH detector for identifying charged π and K mesons in a super-B factory experiment (Belle II) to be performed at the High Energy Accelerator Research Organization (KEK), Japan. The ARICH detector is a ring-imaging Cherenkov counter that uses silica aerogel as a radiator and hybrid avalanche photo-detectors as position-sensitive photo-sensors which are installed at the endcap of the Belle II spectrometer.

The particle identification performance of the ARICH detector is basically measured by the Cherenkov angular resolution and the number of detected photoelectrons. At momenta below 4 GeV/c, to achieve high angular resolution, the refractive index of the aerogel must be approximately 1.05. A scheme for focusing the propagation pass of emitted Cherenkov photons on the photo-detectors is introduced by using multiple layers of aerogel tiles with different refractive indices. To increase the number of detected photoelectrons, the aerogel is expected to be highly transparent. A support module to install the aerogel tiles is comprised of a cylindrical shape with a diameter of approximately 2.3 m. It is important to reduce adjacent boundaries between the aerogel tiles where particles cannot be clearly identified. Accordingly, larger-sized, crack-free aerogel tiles are therefore preferred. Installing the tiles to the module by trimming them with a water jet cutter and avoiding optical degradation of the aerogel by moisture adsorption during long-term experiments should ultimately result in highly hydrophobic conditions.

By 2013, our group established a method for producing, with high yield, large-area aerogel tiles (18 cm $\times$ 18 cm $\times$ 2 cm; approximately tripled) that fulfilled optical performance level requirements (transmission length ˜40 mm at 400-nm wavelength; almost doubled). This enabled us to divide the module into 124 segments to install the trimmed aerogel tiles. Two aerogel tiles with refractive indices of 1.045 and 1.055 were installed to each segment (total of 248 tiles), thus resulting in a radiator thickness of 4 cm. By 2014, 450 aerogel tiles were mass-produced and optically characterized. After water jet machining, the optical parameters were re-investigated. Ultimately, selected aerogel tiles were successfully installed to the module by the end of 2016.

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