# Fractal geometry of porous silica studied by SANS experiment

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Very recently, it has been understood that fractal is a promising approach to design functional materials because fractal geometries theoretically poses infinity length and surface area, and zero net volume. In relation, fractal geometry of porous silica samples, which were prepared under designed conditions, were investigated by SANS experiments. We have already created Menger sponge-like fractal bodies (fractal porous silica) and established the experimental strategy how fractal dimension D can be modified. We found that the Menger sponge-like fractal geometries were created in porous silica with D = 2.5-2.7 in the scale range between 50 nm and 5 um in which connected network structures of pore exist. In this experimental strategy, wax particles of alkylketene dimer (AKD) with flower-like surface structure (particle diameter ca. 10 um, thickness of a petal ca. 100 nm) were utilized as template particles and tetramethyl orthosilicate (TMOS) was used to fill the space between the particles and polymerized by a sol-gel synthesis of TMOS. After calcination of the reaction products, fractal porous silica samples were obtained. However, the distribution of the porous network structure, i.e., scale range of fractal geometry, was limited in the scale range of 50 nm ~ 5 um. To develop the network structure in smaller scale range less than 50 nm, we utilized polymer chains such as polyethylene glycol (PEG) and calf thymus DNA as other type of templates to make smaller pores. We systematically prepared fractal porous samples at different concentrations of PEG and DNA, and also different molecular weight of PEG. As a result, we found an experimental strategy to develop the pore network structure in smaller scale (less than 50 nm). Fig. 1 is a typical example how SANS profile depends on sample preparation. The profiles in the range of 0.01 ~ 0.1 1/A are almost same, but, the profiles in lower Q range less than 0.01 1/A reflect the condition of templates. With an increase of the concentration of PEG20000, it was observed that the profile in lower Q range goes up. We thus found a possibility that the profiles may obey a power law of scattering intensity I (Q) ~ I^(-D) under a suitable condition. Along this strategy, we would like to create fractal porous silica in which D is maintained in several nanometer to several micrometer.

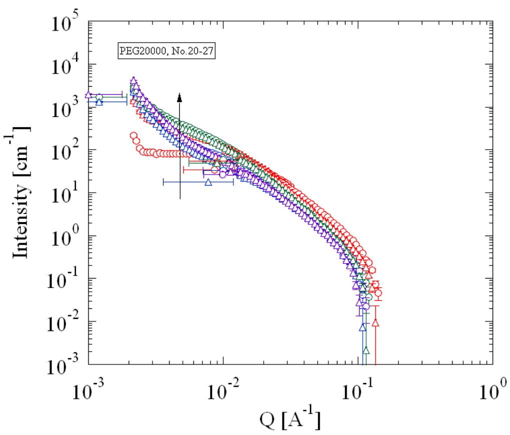


Fig. 1. SANS profiles of fractal porous silica using wax particles, calf thymus DNA and PEG20000 as templates