

## Supplementary Information

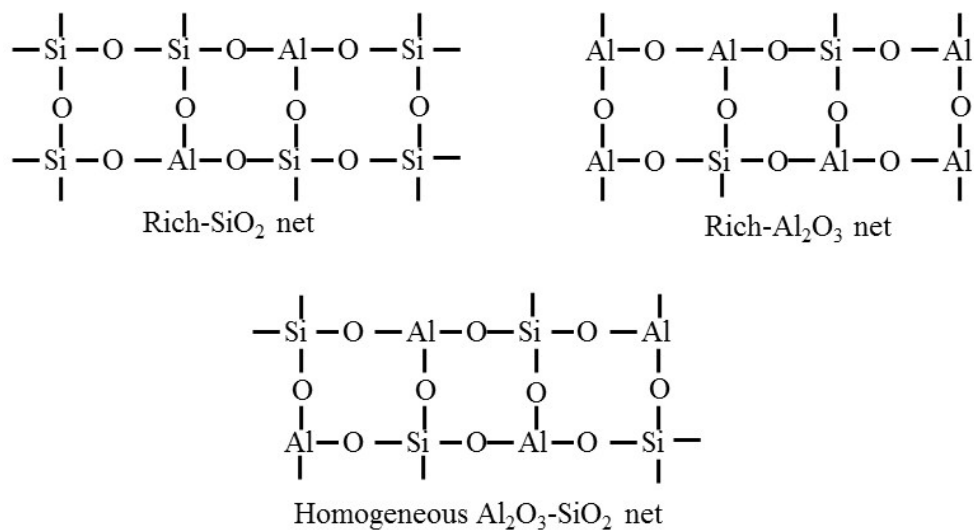


Fig. S1 Different Al-Si net sketches within Al<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub> composite gel

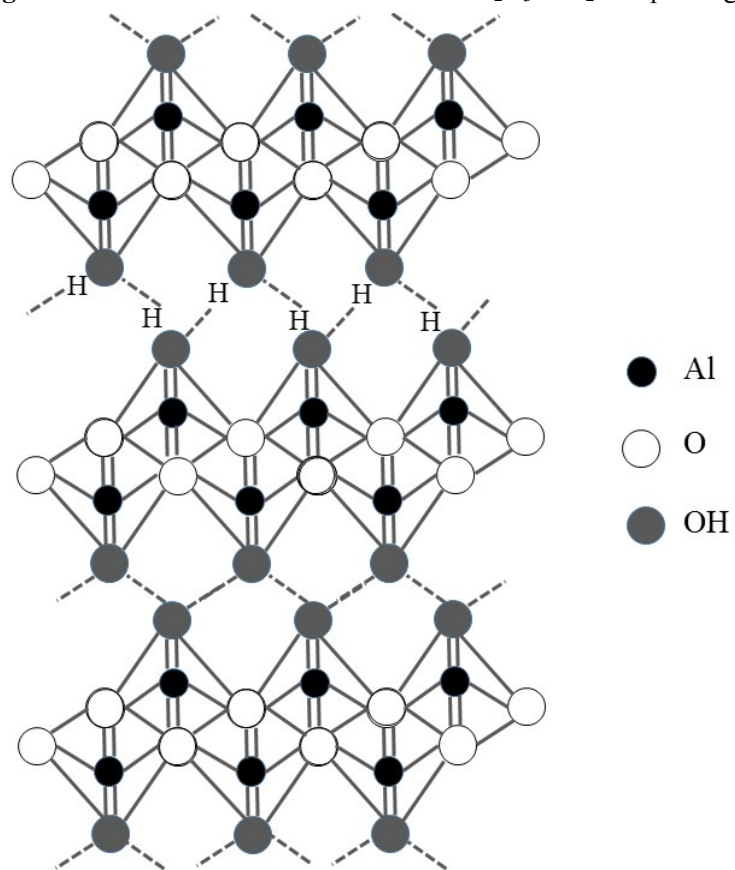
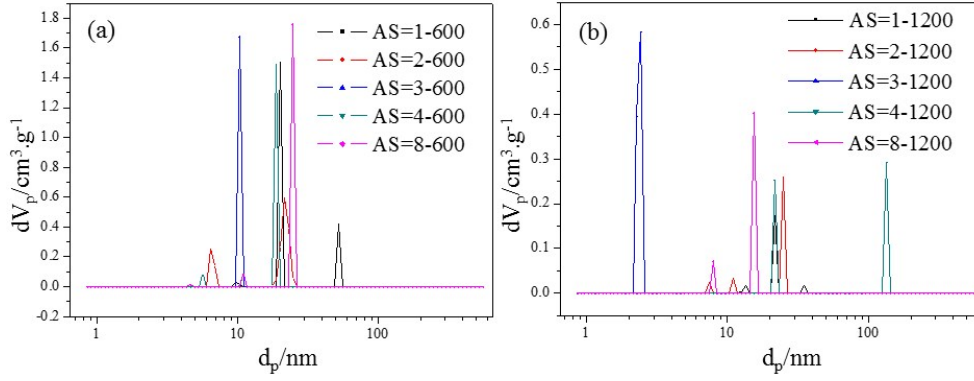


Fig. S2 Schematic diagrams of the AlOOH lamellar structure



**Fig. S3** Pore size distributions calculated by NLDFT method of  $\text{Al}_2\text{O}_3$ - $\text{SiO}_2$  composite aerogel with different Al/Si molar ratios heat-treated at (a) 600 °C and (b) 1200 °C

**Table S1** Some experimental values of the composite aerogels with different Al/Si molar ratios

Material	Bottom radius/cm	Upside radius/cm	Height/cm	Mass/g	Volume/cm <sup>3</sup>	Density/(g.cm <sup>-3</sup> )
AS=8	2.050	1.900	3.200	2.078	39.212	0.053
AS=4	2.000	1.800	3.100	2.260	35.172	0.064
AS=3	2.000	1.750	3.200	2.694	35.377	0.076
AS=2	2.000	1.700	2.800	2.559	30.157	0.085
AS=1	2.000	1.750	2.800	2.963	30.955	0.096

**Table S2** Thermal performance parameters of the mullite fiber mat reinforced  $\text{Al}_2\text{O}_3$ - $\text{SiO}_2$  composite aerogel composites with different Al/Si molar ratios

Al/Si molar ratios	Thermal conductivity (W.m <sup>-1</sup> .K <sup>-1</sup> )	Thermal diffusivity (mm <sup>2</sup> /s)	Specific heat capacity (cm <sup>3</sup> /g)
2	0.023	1.489	0.016
3	0.029	1.237	0.024
8	0.025	1.758	0.015