Supplementary Information for :

Highly robust SiCOH/mesoporous SiO_2 ultralow dielectric films with heterostructures

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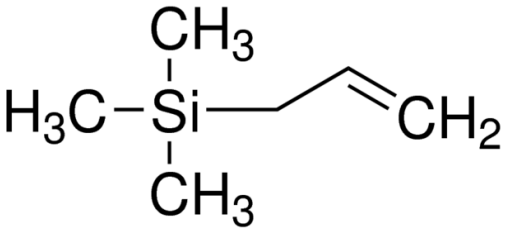

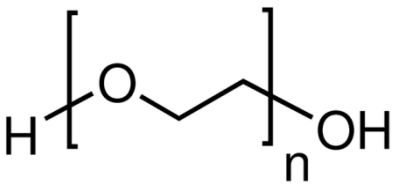

ATMS (top matrix) **PEG (porogen)** **SBA-15 (bottom matrix)**

Fig. S1. Molecular structure of ATMS, PEG, and SBA-15 used as the matrix and labile phase source, respectively.

Table S1. Properties of mesoporous SiO_2 powders.

Type	Size (nm)	Pore size (nm)	Surface area (m^2/g)
SBA-15	**-**	**7.4**	**802**
MCM41	4.5 ~ 4.8	2.1~2.7	1000
Porous SiO_2	5 ~ 15	Spherical	590 ~ 690
SiO_2 nanopowder	12	-	175~225

Table S2. Mechanical properties of mesoporous SiO_2/PEG composite films.

Materials	Modulus (GPa)	Hardness (GPa)
SBA-15/PEG	**2.93**	**0.10**
MCM41/PEG	1.42	0.07
Porous SiO_2/PEG	1.85	0.04
SiO_2 nanopowder/PEG	4.04	0.05

SBA-15 has high modulus and hardness among mesoporous silicas with high surface area (~800 m^2/g). We selected SBA-15/PEG as a buffer layer of SiCOH/mesoporous SiO_2 composite films for this reason.

Table S3. A comparison table between this study and previously reported dielectric constants and moduli of low-k SiCOH films.[33-37,48-51]

Dielectric constant	Modulus [GPa]	Ref.
2.6	6.4	Jousseaume et al., *J. Electrochem. Soc.*, 2007.
2.4	3.5	Burkey et al., *J. Electrochem. Soc.*, 2004.
2.4	9	Frot et al., *Adv. Funct. Mater.*, 2012.
2.4	**8.4**	**Park et al., *J. Mater. Chem. C*, 2013.**
2.3	5.9	Rathore et al., *Adv. Funct. Mater.*, 2008.
2.3	4.1	Dubois et al., *Proc. IEEE Int. Interconnect Technol. Conf.*, 2005.
2.2	6~7	Eslava et al., *J. Am. Chem. Soc.*, 2008.
2.2	5.4	Trujillo et al., *Adv. Funct. Mater.*, 2010.

2.0	**4.3**	***This work***