Facile Synthesis of SiO_x@C Core−Shell Particles as the Anode Material for Lithium Ion Batteries

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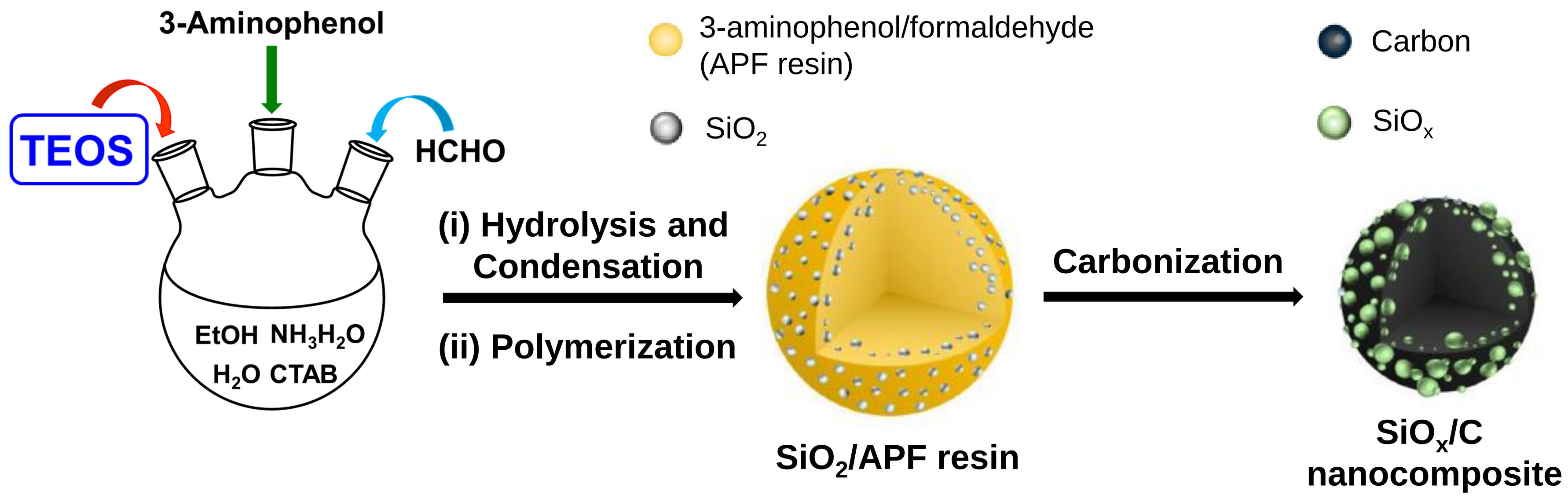
Previous work

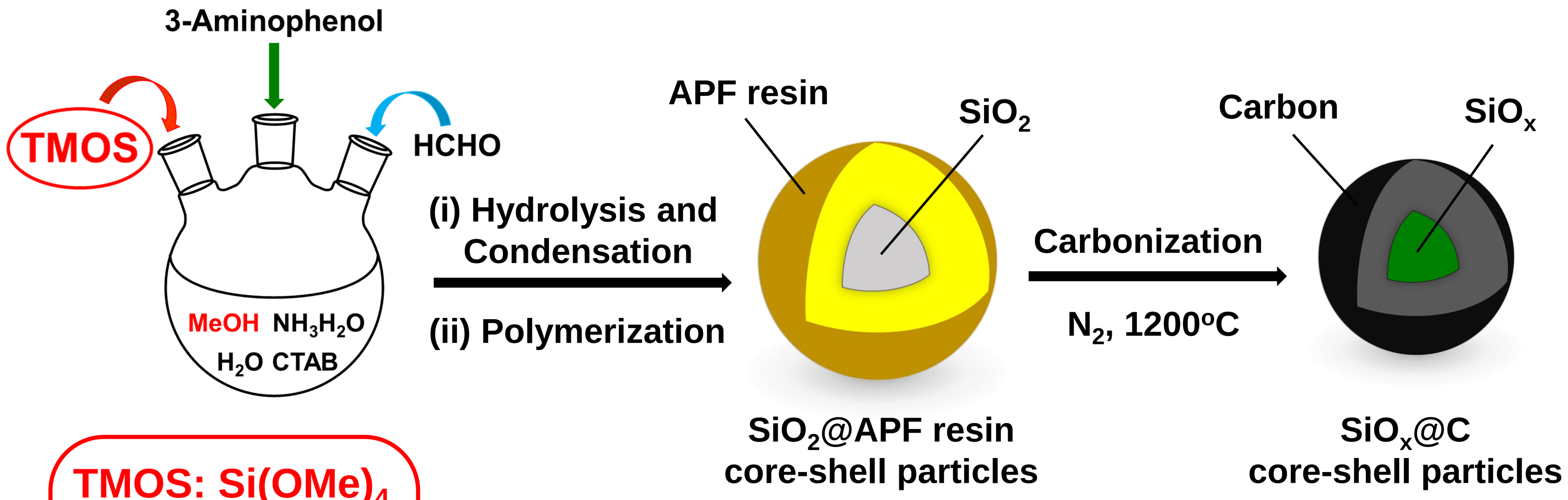


SiO_x nanoparticles were dispersed on the polymer surface and the carbon layer did not perfectly coat SiO_x, leading to a low reversible capacity.

=> Precise design and control the structure of SiO_x/C will be necessary.

T. Izawa et al., *Mater. Res. Bull.* **2019**, 112, 16

This work

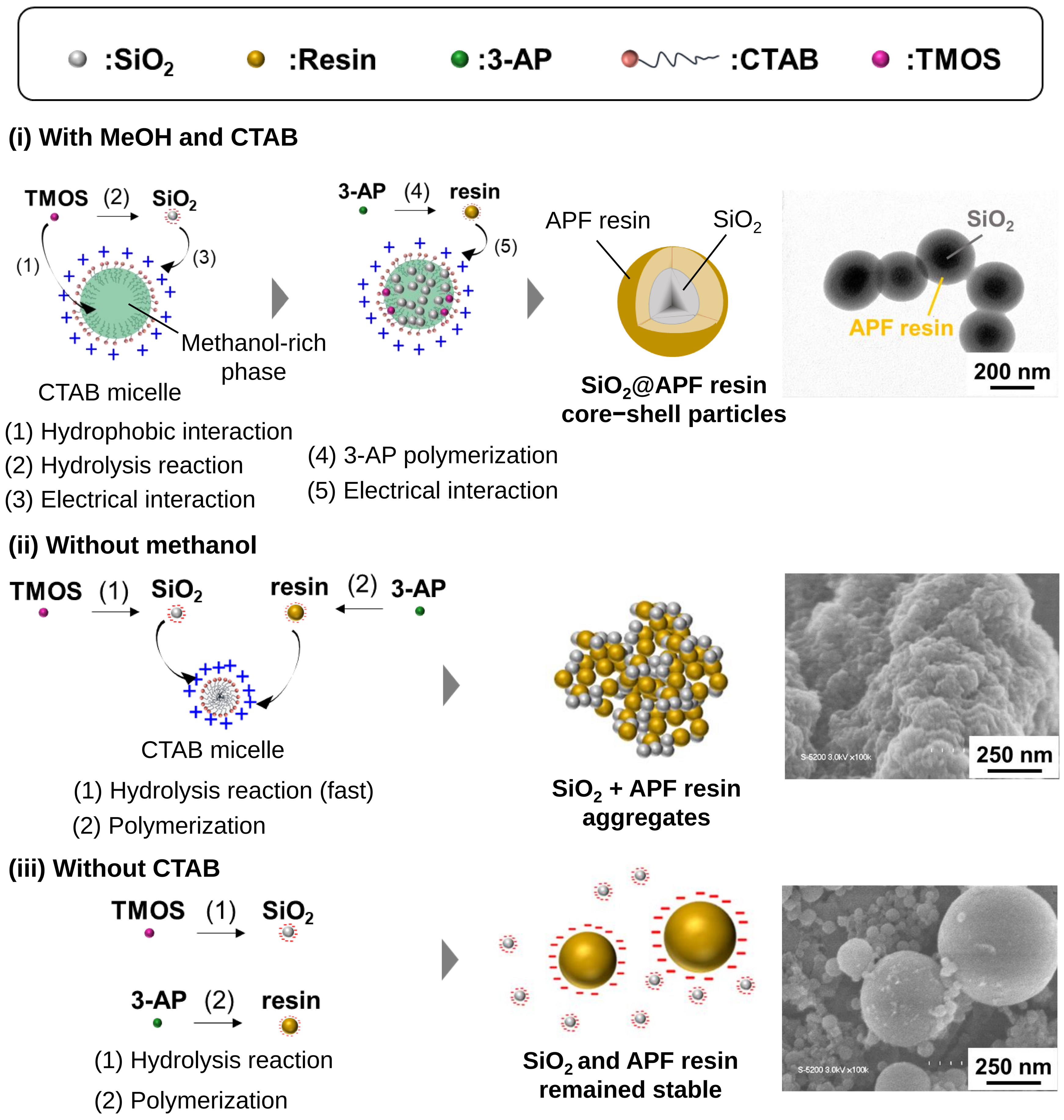


TMOS: $Si(OMe)_4$
- ✓Fast reaction rate
- ✓Inexpensive
- ✓Readily available
- ✓Simple to handle
- ✓Easy to remove

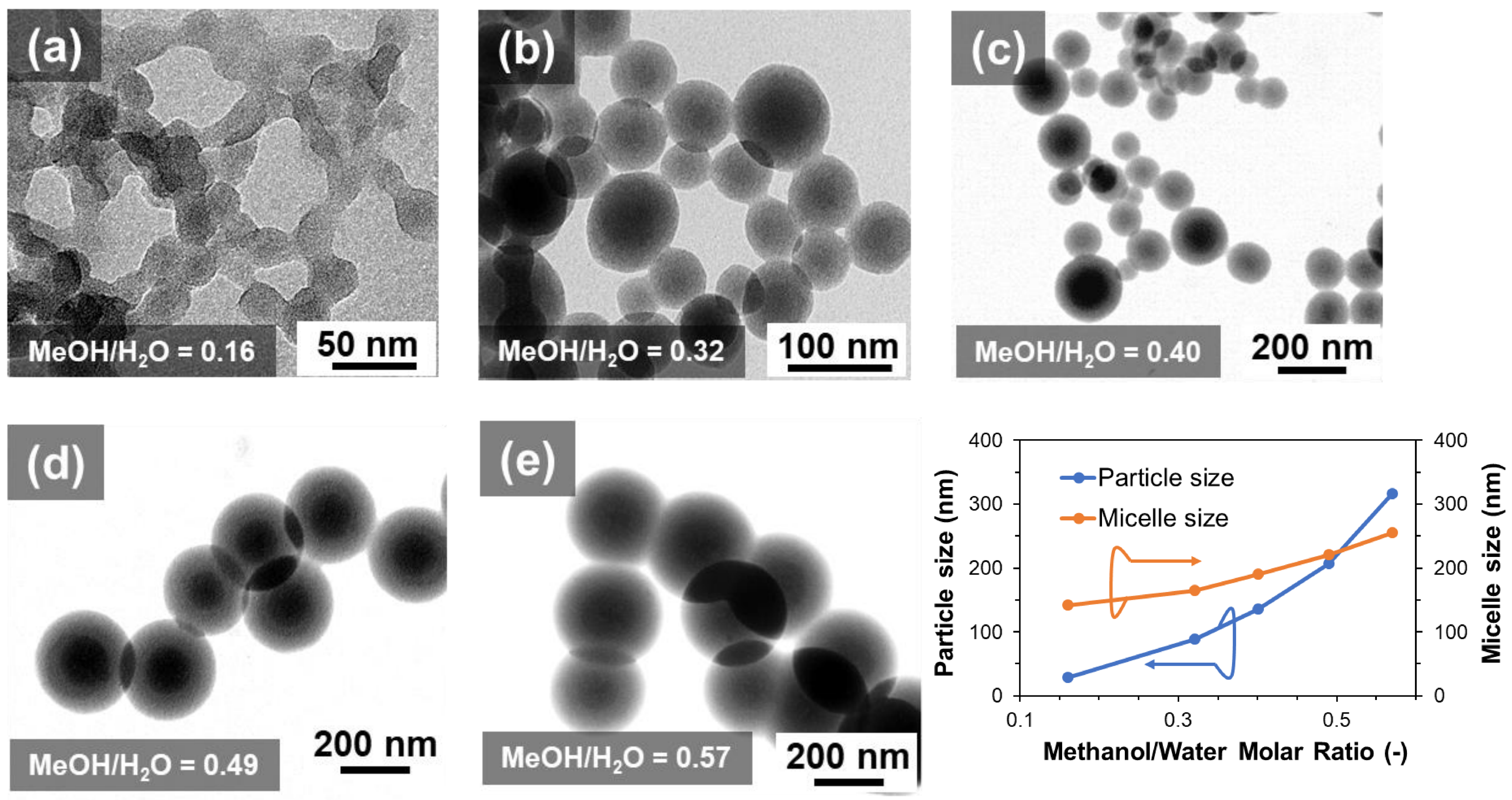
The core−shell particles can be obtained by using TMOS as an effective silica precursor ***for the first time*** with a well-controlled reaction rate and spherical morphology.

K. L. A. Cao et al., *Langmuir* **2019**, 35(*42*), 13681

Formation mechanism of SiO_2@APF resin particles

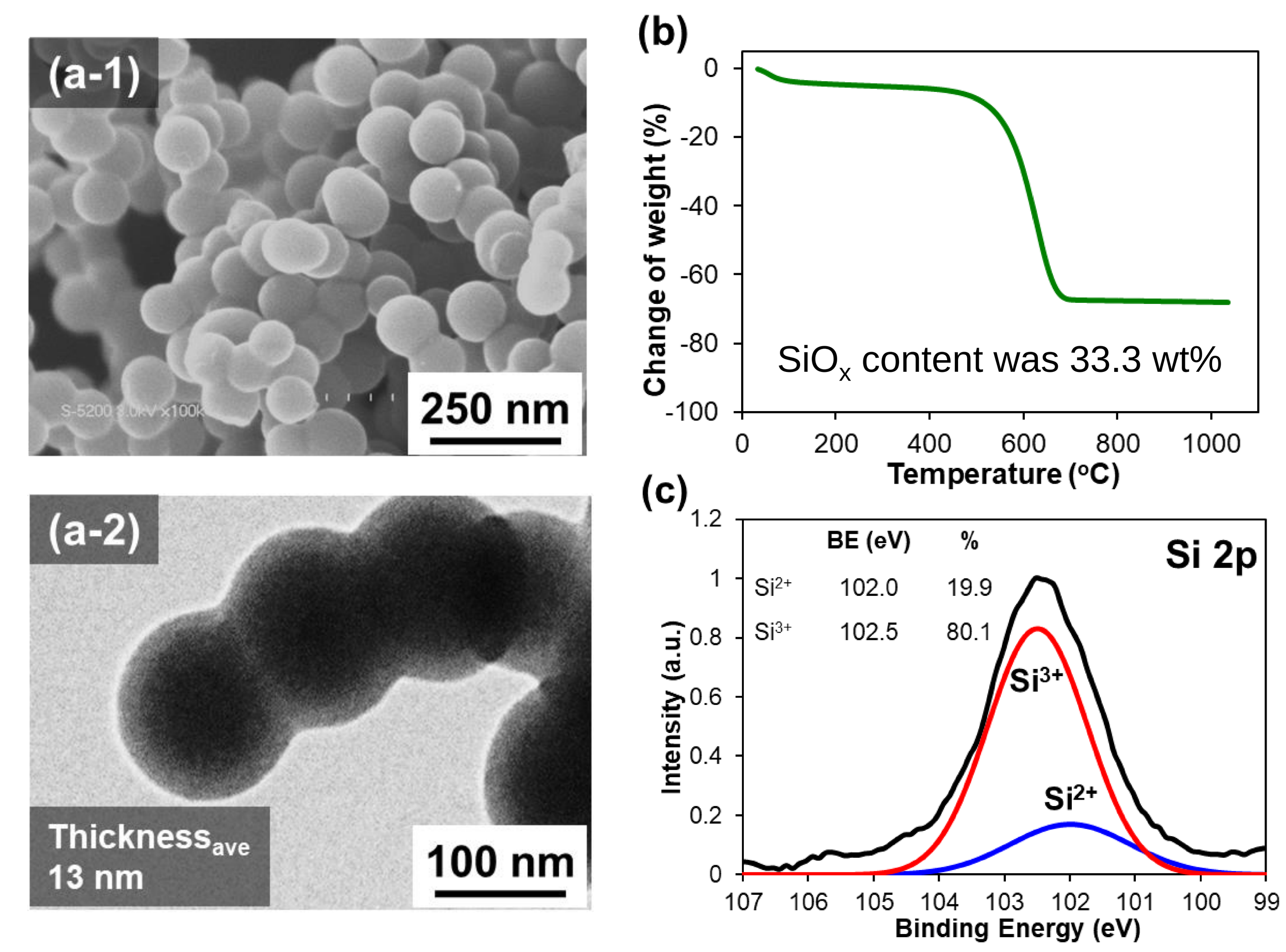


Effect of MeOH/H_2O ratio on particle morphology



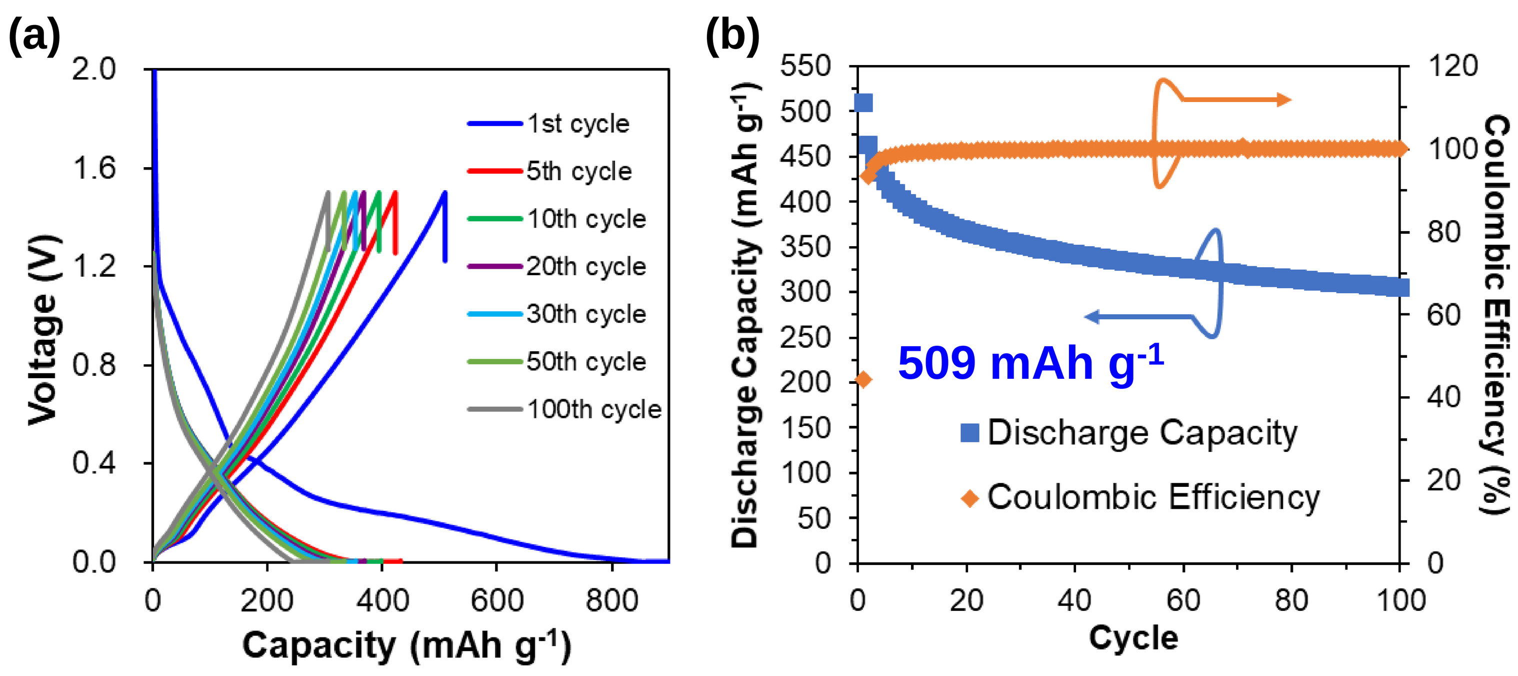
- ✓ The particle size increased with increasing MeOH/H_2O ratio from 0.16 to 0.57.
- ✓ The core-shell structure was formed at a MeOH/H_2O ratio from 0.32 to 0.57.

Characterization of SiO_x@C particles



- ✓ After carbonization, the SiO_x@C maintained their structural integrity and spherical morphology.
- ✓ The XPS results indicated that there were different chemical states of Si in SiO_x, which was caused by carbothermal reduction occurring between SiO_2 and carbon during heating process.

Electrochemical analysis of SiO_x@C particles



- ✓ The obtained SiO_x@C particles delivered a reversible capacity of 509 mAh g^{-1} at 100 mA g^{-1} and the capacity retention was approximately 80% after 100 cycles.
- ✓ The SiO_x@C particles with core−shell structure guarantee optimum contact with the carbon matrix and the round shape of carbon shell is highly resilient toward stress.

Conclusions

- ✓ We have successfully synthesized SiO_x@C core−shell particles via a sol−gel method followed by a carbonization process, using TMOS instead of the traditionally used TEOS.
- ✓ The core−shell particles can be obtained with a well-controlled reaction rate and spherical morphology by using TMOS as an excellent silica precursor for the first time.
- ✓ When used as the anode material for LIBs, the electrochemical performance significantly improved compared with our previous study owing to the morphology and structure of the material.

◆ **Reference** K. L. A. Cao et al., *Langmuir* **2019**, 35(*42*), 13681-13692

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