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www.elsevier.com/locate/memsci

PII: S0376-7388(17)31382-0
DOI: https://doi.org/10.1016/j.memsci.2017.10.001
Reference: MEMSCI15627

To appear in: *Journal of Membrane Science*

Received date: 12 May 2017
Revised date: 28 September 2017
Accepted date: 1 October 2017

Cite this article as: Bijin Xiong, Ran Chen, Fangxinyu Zeng, Jian Kang and Yongfeng Men, Thermal shrinkage and microscopic shutdown mechanism of polypropylene separator for lithium-ion battery: *In-situ* ultra-small angle X-ray scattering study, *Journal of Membrane Science,* https://doi.org/10.1016/j.memsci.2017.10.001

Thermal shrinkage and microscopic shutdown mechanism of polypropylene separator for lithium-ion battery: *In-situ* ultra-small angle X-ray scattering study

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Abstract

Structural variation and shutdown behavior of polypropylene separator for lithium-ion batteries upon heating have been investigated via *in-situ* ultra-small angle X-ray scattering (USAXS) tests. Structural parameters including porosity, specific interface and pore size have been successfully estimated by fitting the scattering intensity with craze model. The fitting results reveal that cylindrical pores are oriented in stretching direction with average length of 155 nm and radius of 63 nm. *In-situ* USAXS results show that the shutdown of the polypropylene separator initiated from the temperature of 152 ^{o}C which is close to the onset of the melting temperature. The shutdown of the pores has been found to be originated from the melting of crystals which leads to the release of the internal shrink force. Two driving forces, i.e. shrinking force from oriented chains and surface tension of nanosized pores, have been revealed. It was demonstrated that the shrinking force is the major driving force at the initial stage and the surface tension controls the shutdown at the final stage.

Graphic Abstract