



Contents lists available at ScienceDirect

## Journal of Industrial and Engineering Chemistry

journal homepage: [www.elsevier.com/locate/jiec](http://www.elsevier.com/locate/jiec)1 Surface-initiated fluoride-scavenging polymeric layer on cathode  
2 materials for lithium-ion batteries3 **Qi** Hyo Ree Seo<sup>a,1</sup>, Hae Ri Lee<sup>a,1</sup>, Dong-Ku Kang<sup>b</sup>, Taeun Yim<sup>b,\*</sup>, Si Hyoung Oh<sup>a,\*</sup>4 <sup>a</sup> Korea Institute of Science and Technology, Seongbuk-gu, Seoul 02792, Republic of Korea5 <sup>b</sup> Department of Chemistry, Incheon National University, Incheon, 22012, Republic of Korea

## ARTICLE INFO

## Article history:

Received 23 March 2017

Received in revised form 11 May 2017

Accepted 13 May 2017

Available online xxx

## Keywords:

Lithium manganese oxides

Spinel

Poly(dimethylsiloxane)

Fluoride scavenging

Manganese dissolution

## ABSTRACT

Spinel-structured lithium manganese oxides (LMOs) suffer from manganese dissolution at elevated temperatures, which leads to severe capacity fading. In this work, a novel strategic approach was developed to alleviate this phenomenon by using poly(dimethylsiloxane) (PDMS) as a simple and scalable electrode additive. LMO electrodes containing finely dispersed PDMS were prepared using a conventional electrode coating process. Electrochemical studies showed that the PDMS-dispersed LMO electrodes had significantly improved cycling retentions. *Ex-situ* FT-IR and <sup>19</sup>F NMR spectra indicated PDMS chemically scavenged the F<sup>-</sup> species, which cause manganese dissolution in LMO-based cells. In addition, a plausible mechanism was proposed based on the spectroscopic evidences.

© 2017 The Korean Society of Industrial and Engineering Chemistry. Published by Elsevier B.V. All rights reserved.

## 6 Introduction

7 Lithium-ion batteries (LIBs) entered commercial markets in  
8 1991. Since their introduction, their application has rapidly  
9 expanded from small- to large-scale devices, such as smartphones,  
10 laptop computers, electric vehicles, and uninterruptible power  
11 supplies [1–3]. The properties of LIBs depend primarily on their  
12 electrode materials, which determine the electrochemical perform-  
13 ance of the cells, including their capacities, operating voltages,  
14 and rate capabilities. Therefore, many types of electrode materials  
15 have been developed to meet the specific requirements of LIBs  
16 used in a variety of applications [4–10].

17 Recently, the use of spinel-type lithium manganese oxides  
18 (LMOs) as a cathode material in LIBs for electric vehicles has gained  
19 much interest. LMOs contain three-dimensional diffusion chan-  
20 nels, which provide favorable pathways for Li<sup>+</sup> ion intercalation.  
21 Thus, LMOs show significantly improved kinetic behavior com-  
22 pared to that of LiCoO<sub>2</sub>, a conventional layered cathode material  
23 [11–14]. Therefore, LMO may be a suitable electrode material for  
24 use in high-power devices. However, the practical application of  
25 LMO is seriously hindered by its chemical instability at elevated  
26 temperatures, which leads to poor cycling behavior of the resultant  
27 cells [15,16]. An LMO electrode charged to a high potential and an

electron-deficient LMO exposed to elevated temperatures can  
stabilize by receiving additional electrons. These cells contain  
nucleophilic fluoride (F<sup>-</sup>) species because of the reaction between  
the lithium salts (LiPF<sub>6</sub>) and the trace amount of water molecules  
present in the cell components [17–19]. The F<sup>-</sup> ions can attack the  
electrophilic Mn atoms of LMO, resulting in the dissolution of Mn  
into the electrolyte. This mechanism is mainly responsible for the  
capacity fading of the LMO cathodes [20–22]. Furthermore, the  
dissolved Mn ions will migrate towards the anode and are likely to  
be deposited on its surface. This seriously disturbs the formation of  
solid electrolyte interface (SEI) layers, which are associated with  
the stable cycling of anode materials [23–25]. Therefore, it is  
necessary to minimize Mn dissolution to maintain the perform-  
ance of LIBs constructed using LMO.

Many attempts have been made to reduce Mn dissolution, such  
as applying protective polymeric layers on the LMO cathode  
materials. For example, the use of lithium poly(acrylate) [26], poly  
(pyrrole) [27], and poly(3,4-ethylenedioxythiophene) [28] proved  
effective in preventing the erosion of Mn at the electrode/  
electrolyte interfaces. On the other hand, functional electrolyte  
additives have also been widely investigated to reduce the Mn  
dissolution behavior [29–35]. This approach is based on the  
chemical scavenging of nucleophilic F<sup>-</sup> by additives. Although  
these additives are effective, they have several practical limita-  
tions. For instance, F<sup>-</sup>-scavenging additives often decrease the  
ionic conductivities of the electrolytes, resulting in poor Li<sup>+</sup>  
transportation kinetics. In addition, these types of additives are  
usually extremely electrophilic and easily decompose on the anode

\* Corresponding authors.

E-mail addresses: [yte0102@inu.ac.kr](mailto:yte0102@inu.ac.kr) (T. Yim), [sho74@kist.re.kr](mailto:sho74@kist.re.kr) (S.H. Oh).<sup>1</sup> These authors contributed equally to this work.



Download English Version:

<https://daneshyari.com/en/article/6667885>

Download Persian Version:

<https://daneshyari.com/article/6667885>

[Daneshyari.com](https://daneshyari.com)