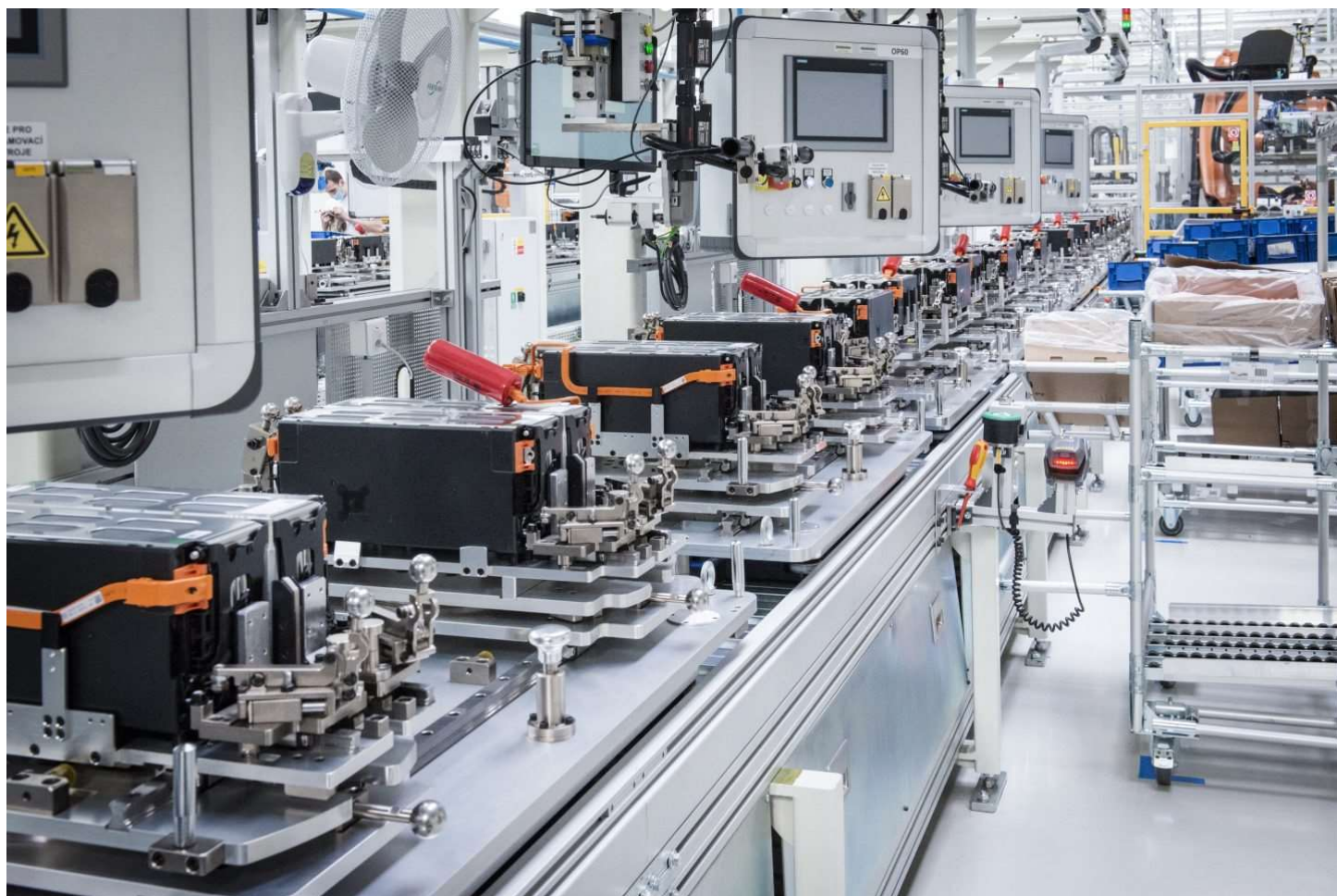




## RQA RISK ENGINEERING REPORT

## Lithium Ion Batteries – Introduction and Manufacturing Risks



Reading Enterprise Centre, Whiteknights Road, Reading RG6 6BU, UK  
Tel: +44 (0)118 935 7242

[www.rqa-group.com](http://www.rqa-group.com)

## Contents

<b>1. Introduction .....</b>	<b>3</b>
<b>2. Anodes and cathodes .....</b>	<b>4</b>
<b>3. Cell types.....</b>	<b>4</b>
<b>4. Lithium battery packs.....</b>	<b>5</b>
<b>5. Lithium ion battery manufacturing process.....</b>	<b>6</b>
<b>6. Potential manufacturing errors .....</b>	<b>6</b>
<b>7. Examples of errors in the manufacturing process that have led to recall .....</b>	<b>7</b>
<b>8. What is best practice in Lithium Ion battery manufacture?.....</b>	<b>8</b>
<b>9. Other related reports.....</b>	<b>9</b>

## Copyright

© RQA Europe Limited, trading as RQA Group, 2021. This edition published January 2021.

All the content in this RQA Risk Engineering Report, is the property of and copyrighted by RQA Group. It is licensed to a named user (identified in the header of the report) for personal or internal company use only. You may not adapt, distribute outside the purchaser's company, commercially exploit, or publicly display the report or any portion thereof in any manner whatsoever without RQA's prior written consent.

## Lithium Ion Batteries – Introduction and Manufacturing Risks

### 1. Introduction

Lithium is a Group I, Alkali Metal. Lithium is the lightest metal and an excellent electrical conductor, making it the most promising material for battery electrodes.

Primary lithium batteries (non-rechargeable) have been sold since 1973. The first secondary (rechargeable) Lithium battery was developed based upon primary battery technology, using metallic lithium as the negative electrode (anode). However, this battery was not successful due to the short life and safety issue posed by metallic Lithium when undergoing recharge. Lithium metal is very reactive with moisture. Therefore focus turned to using Lithium ion (Li<sup>+</sup>) in rechargeable batteries instead of the metallic form.

In 1991, Sony produced the first commercially available rechargeable Lithium ion battery. Lithium metal in the primary battery was replaced by Carbon as the negative anode and Lithiated Cobalt oxide was used as the positive cathode. The properties of Lithium ion batteries made them ideal for use in portable electrical appliances.

Rechargeable Lithium ion batteries comprise two electrodes (anode and cathode), separated by an electrically insulating but ion conducting liquid known as the electrolyte. The electrolyte is on a porous separator that enables the transfer of lithium-ions from one electrode to the other.

The layered structure of electrode materials facilitated intercalation of Lithium ions into the crystalline lattice of the host electrode. The typical reaction can be represented as:

At Cathode (positive)



At Anode (negative)



Overall reaction



The electrolyte is a non-aqueous solution of Lithium salts, Lithium hexafluorophosphate (LiPF<sub>6</sub>) and Lithium tetrafluoroborate (LiBF<sub>4</sub>) in Organic carbonate (Ethylene carbonate, EC, Propylene carbonate, PC, Dimethyl carbonate, DMC).