

Structural Analysis of Nokia BL5C and Substandard Batteries - Issues and Threats

Narayanan.S¹, Saravanan Kumar.M²
Department of Electronics and Communication Engineering,
Renganayagi Varatharaj College of Engineering,
Sivakasi, Tamilnadu, India.

ABSTRACT

In the present era, Lithium-ion batteries are highly preferred power packs for a range of widely used consumer products, particularly mobile phones. Li-ion battery packs are weightless and high energy storage capacity, so they are suitable for mobile phones power sources. Lithium is the lightest ion, and it has the enormous amount of storage capacity. On the dark side this is a unbalanced metal and also gradually losing its efficiency from the first day. Mobile phone requires replacement of batteries every two years or after 500 recharge cycle. Li-ion battery is never to be used alone, it requires a current interrupt device (CID), Anti-flaming vent and PTC is to maintain safe life-cycle process. Safety standards are over ruled for cost reduction which is a highly sensitive issue for manufacturing the Li-ion battery technology. Most of low cost batteries, particularly Chinese made, contain cheap mechanical design, ignoring PTC and electronic components. E-Commerce is a vital platform distributing these types of batteries globally. The sub-standard manufactured Li-ion batteries are highly unsafe for consumers and they are capable of explosion and fire. This paper analyzes safety issues of Li-ion batteries, sub-standard manufacturing and marketing threats under sampling of NOKIA BL5C.

Keywords - BL5C, CID, E-commerce, Li-ion, Mobile, Nokia, PTC, Safety, Substandard.

I. INTRODUCTION

The large scale requirement of portable electronics such as cell phones, personal music players, and laptops, necessitate to drive the market for manufacturing rechargeable secondary lithium-ion cells. Currently all the mobile phone batteries are works well with prismatic typed Li-ion technology. Li-ion batteries having energy storage capability of 3 times the other rechargeable batteries like Nickel cadmium (NiCd), Nickel Metal Hydride (NiMH) batteries. The key factors for selecting

the Li-ion batteries are variety of models available, compact size, low price, high storage capacity, nominal charging times and prolonged life time. However, as the use of lithium batteries is growing globally and with the large number of batteries powering a wide range of products in a variety of usage environments [1]. Li-ion battery packs have weightless and high energy storage capacity; hence they are perfect match for mobile phones power sources. Lithium ion batteries having high voltage density of 3.6V and current rating up to 3000 MaH that is widely used in the mobile phones equipment.

II. CHARACTERISTIC OF BL5C

Nokia BL5C is available in prismatic pack only. These packs have storage capacity of 1150 MaH and operational voltage is 3.7V. Nokia BL5C requires constant current and constant voltage for charging. Charging voltage for those packs it will not be exceeding 4.2V.[2] Around 50 Nokia mobile models are using this battery from their low cost monochrome display model 1100 to higher end Symbian operating system model of N72. On the other hand, several Chinese manufacturers like G-five, AGtel, Olx, Lephone, YXtel are also used BL5C for their model power sources. Currently BL5C pack is highly required model for replacement in battery market.

III. BL5C BATTERY SAFETY RECALL

Nokia recalls 46 million packs of BL5C battery that was manufactured by their third party Chinese manufactured vendor Matsushita Battery Industrial Co (MBI) between December 2005 and November 2006.[3] The particular manufactured batch of BL-5C battery packs produce overheating as a result of short circuiting while charging. Nokia received 100 cases of overheating reported globally to that date but no cases of serious consumer injury or mobile phone damage have emerged from the BL-5C battery malfunction.

IV. SAFETY CIRCUITS INSIDE THE BATTERY

Basically Li-ion battery manufacturing requires quality and safe mechanical design as well as electronic design. Li-ion battery required three basic management systems for safe and prolonged operation. [4]

- Thermal or unstable sense management
- High quality and exact mechanical design management ,
- Electronic sensing and cut-off management

Li-ion batteries chemical solvents are capable of explosion when batteries are excessively charged. Explosive chemical solvents produce consumer's burn injury and ruin mobile phones. Battery management systems (BMS) are safe for battery and running operation in mobile phones. [5]

4.1 THERMAL MANAGEMENT

The Positive Temperature Coefficient (PTC) that is to save the Li-ion battery packs from overheating. The PTC (thermistor) device built into the Li-ion pack works as a productive device to prevent high current flows. [6] It responds to immediately when high current discharge levels are to raise output impedance. The raised impedance sense to output current and the PTC can separate the positive terminal of battery output path, if the discharge levels surpass safe limits. Most of the sub-standard manufactures ignoring PTC due to rise in the manufacturing cost.

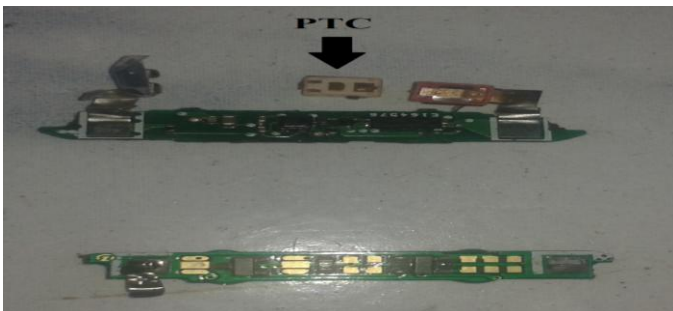


Fig.1. No sign of PTC in Substandard battery.

4.2 ANTI-FLAMING VENT

All the Li-ion batteries have an outer case made of aluminum metal. The use of aluminum metal case is particularly vital here because the battery is pressurized in charging and discharging mode. This metal case has

presence of small and tiny aluminum foil covered Anti-flaming vent hole. Original and high quality manufactured batteries normally contain a mechanical vent provided in the outer aluminum case of the battery. This one time used vent is designed to release internal pressure within the battery during a disorder of abuse to avoid an explosion. Sub-standard manufactured batteries never contain an Anti-flaming vent hole. If pressure and heat is generated inside the battery packs due to overcharging or over discharging or even mal-function of battery charger increases the internal pressure, which in turn results in explosion due to the absence of vent[7].



Fig.2. Anti Flaming Vent present in OEM battery

4.3 CURRENT INTERRUPT DEVICE (CID)

The protective circuit, Current Interrupt Device (CID) works very effectively in protecting the battery under any irregular and serious conditions. Battery overcharged above 5.0V or under charged below 3.8V the sensing IC in CID is activated and MOSFET switches off, discontinuing charging and preventing battery from the explosion. [8] Another vital role of CID MOSFET is that, it switches off charging, when battery is fully charged. Also shutdown battery to avoid battery fully discharging mode. It is also meant to check the temperature for safe running operation and to increase the life cycle of the battery packs.

V. THREATS OF LI-ION BATTERY

5.1 COST REDUCTION

In 1994, the price in the production of Li-ion batteries with a capacity of 1,100 mAH was more than 10\$. In 2001, the price fell down to 2\$ and the capacity rose to 1,900mAh. In the last decade, high energy-dense Li-ion cells deliver over 3,000 mAH in a price less than 1\$. In 2013 it was further down to 0.5 \$. Low cost reduction

destroys li-ion battery technology in manufacturing and marketing. [9] Currently the substandard batteries are available in Chinese e-commerce portals from 0.1\$(less than 6 rupees)



Fig.3. Substandard Battery Sales through E-Commerce

5.2 HUMAN INJURY

There have been several incidents reported in the use of globally of substandard batteries and it is regularly reported for explosion or venting. Substandard manufactured batteries cause damage to the mobile phones, human body and sometime both.

In July 2013 Swiss female painting artist suffered from her Samsung S3 mobile phone explosion in his workplace due to the replacement of substandard batteries. She was admitted in the hospital after the explosion. She suffered the third degree burn on his right thigh and her Samsung S3 completely damaged in this incident.



Fig.4. Exploded Samsung S3 mobile

Samsung officials said that the explosion of the battery was not manufactured by the Samsung; and reports that she uses third-party substandard battery caused the explosion. Swiss Federal Institute for Materials Testing and Development Laboratory also investigated about the explosion [10]. Finally they also confirmed that the off market replacement battery caused the explosion.

VI. ISSUES ON SUBSTANDARD BATTERIES MARKETING

Substandard batteries manufactured with more toxic and substandard materials may have different capacity usually labeled with high storage capacity. The high storage labeled batteries attracts consumers but they sold without bill and warranty card. Some of the substandard manufacturers are giving mislead information to attract the consumers to buy their products. The key factors include:

- Fake manufacturing origin
- Mislead information
- Excess storage capacity
- No warranty
- E-commerce platforms distributes substandard batteries



Fig.5. Substandard Battery

This substandard batteries having another serious issues and threats involved. The storage capacity of Nokia Original Equipment Manufacturer (OEM) BL-5C has 1020mAh. But these manufacturers indicate their product storage capacity nearby two and half times more than original BL-5C storage capacity. If increase the storage capacity of battery whether increase li-ion chemicals or increase size of the battery. In this issue outer case size of battery cell is same so only way

increase the amount li-ion chemical solvent then only increase storage capacity 2500mah.[11] Increase the chemical solvent in same case pack is really so dangerous and increases the possibility of explosion. This manufacturer also indicates his battery suitable for Nokia model like 1100, 3650. But these are labeled as NOK instead of Nokia. Another serious factor this manufacturer indicates this battery are made in Japan.[12] But there is no production unit is found in Japan. The third world countries people having enormous trust about the product from Japan. The otherside sub standard manufacturerd batteries in china and labled their products are made in japan export globalley. They export nearly 90% for worldwide particularly third world countries. Not only this manufactures there are lots of Chinese manufacturers are product and export these kinds of li-ion batteries' globally. Still now these kinds of batteries offer consumer informs of minor injuries, burns and mobile phone damage. If this continued this way counterfeit batteries surely causes consumer lives too.

All the original manufacturing equipment (OEM) mobile phone manufacturers offer a limited warranty that covers the not only batteries and also other accessories. Indian Cellular Association (ICA), report says 45 million replacement batteries in the Indian mobile market, about 80% are fake version and unsafe for consumers. Consumers are faced with more than 80% to 90% per cent chances of buying substandard battery products that available in a local market where they look like as original. These products pose serious threats to both local sellers and the health of consumers. [13]

China is famous for non-branded and substandard manufacturing Li-ion batteries. An autonomous council is required for monitoring and importing the Li-ion batteries. This council got the power of regularly takes samples and checking the quality of batteries. This council also empowered to fine and cancelled the import licenses of the product importers.

VII. RESULTS AND FINDINGS

- Li-ion battery requires quality manufacturing and respectable mechanical design.
- Substandard li-ion batteries make injuries to the consumer such as burns.

- It may causes rupture ,leakage, explosion ,and fire
- BL5C battery capable product of malfunction.
- Cost is the deciding factor in li-ion battery production.
- Safety circuit that provides safe running operation
- Substandard batteries are not furnished with safety features.
- PTC and anti-flaming vent are not provided by substandard manufacturers.
- E-commerce vigorous platform selling substandard batteries.
- Generation of abnormal amount of heat.
- Consumers have lack of awareness to buy substandard batteries.
- substandard available world wide
- China is the major country producing substandard batteries.
- Incredible price gap between OEM and substandard.

VIII. CONCLUSION

The collective experience of this paper indicates serious issues and threats in mobile battery manufacturing, marketing and selling segments. Li-ion batteries packs are highly safe and trusted technology. But the substandard Chinese manufacturing and marketing peoples are completely destroyed the reputation and questioning about the technology. Currently consumers need to great deal of awareness about the substandard li-ion batteries issues. The awareness should be widespread, with international administrations, consumer safety authorities, and mobiles battery manufacturing and marketing groups, all should jointly work their role and make consumer awareness to avoid of the danger of substandard li-ion batteries .These types of battery packs are likely to malfunction and, they can make partial damage or ruin mobile phones. They may also cause burn injury to consumers, perhaps resulting in death.

REFERENCES

- [1]Isidor Buchmann; the book of *Batteries in a Portable World: A Handbook on Rechargeable Batteries for Non-Engineers, Second Edition Paperback* – May 1, 2001
- [2]Isidor Buchmann; the book of *Is Lithium-ion safe? Major battery recall raises concerns* ,September 2006

- [3]BL-5C safety recall [www.nokia.com/ battery replacement](http://www.nokia.com/battery-replacement)
- [4]Davide Andrea ; *Battery Management Systems for Large Lithium Ion Battery Packs* , Publisher: Artech House: Sep 30, 2010
- [5]Yoshio, Masaki; Brodd, Ralph J.; Kozawa, Akiya *Lithium-Ion Batteries Science and Technologies (Eds.)* 2009, 452 p.
- [6]Marko Dimitrijevic, *Lithium-ion-battery-assembly-challenges*
<http://www.ecnmag.com/articles/2011/01/lithium-ion-battery-assembly-challenges>
- [7]calorimetry ,Perrine Ribière,a Sylvie Grugeon,a Mathieu Morcrette,a Simeon Boyanov,b Stéphane Laruellea and Guy Marlair, *Investigation on the fire-induced hazards of Li-ion battery cells by fire Energy & Environmental Science* Issue 1, 2012 pp. 5271-5280
- [8]H. Michael o brain and Gregg Tatarka *Li-Ion batteries; emerging focus causation in consumer product fires.* 2008.
- [9] N Andrews; *Materials and Processing for Lithium-ion Batteries, The global market for power supply and power management integrated circuits*, Conference and Exposition, APEC 2002. ieeexplore.ieee.org 2002
- [10] <http://www.dailymail.co.uk/health/article-2359281/Exploding-Samsung-Galaxy-phone-leaves-teenager-degree-burns-smelling-like-burnt-pig.htm>
- [11]*Gebrekidan Gebresilassie Eshetu, Sylvie Grugeon, Stéphane Laruelle, Simeon Boyanov, Amandine Lecocq, Jean-Pierre Bertrand and Guy Marlair* , In-depth safety-focused analysis of solvents used in electrolytes for large scale lithium ion batteries by *Physical Chemistry Chemical Physics* Issue 23, 2013 pp. 9145-9155
- [12]<http://www.dhgate.com/store/product/battery-2450mah-bl-5c-for-nokia-c2-06-c2/155606362.html>
- [13]http://articles.economicstimes.indiatimes.com/2007-08-18/news/27683867_1_lithium-ion-batteries-indian-cellular-association-ica