بسم الله الرحمن الرحيم

**Report 2017**

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Title:

**Manufacturing prototype of battery lithium ion**

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# Contents

# 1. Introduction

The purpose of this project is manufacture a lithium-ion battery

## 2. Materials

Materials of lithium cell:

تتألف بطارية lithium من غلاف معدني يحتوي على ثلاث رقائق ملفوفة بشكل حلزوني :

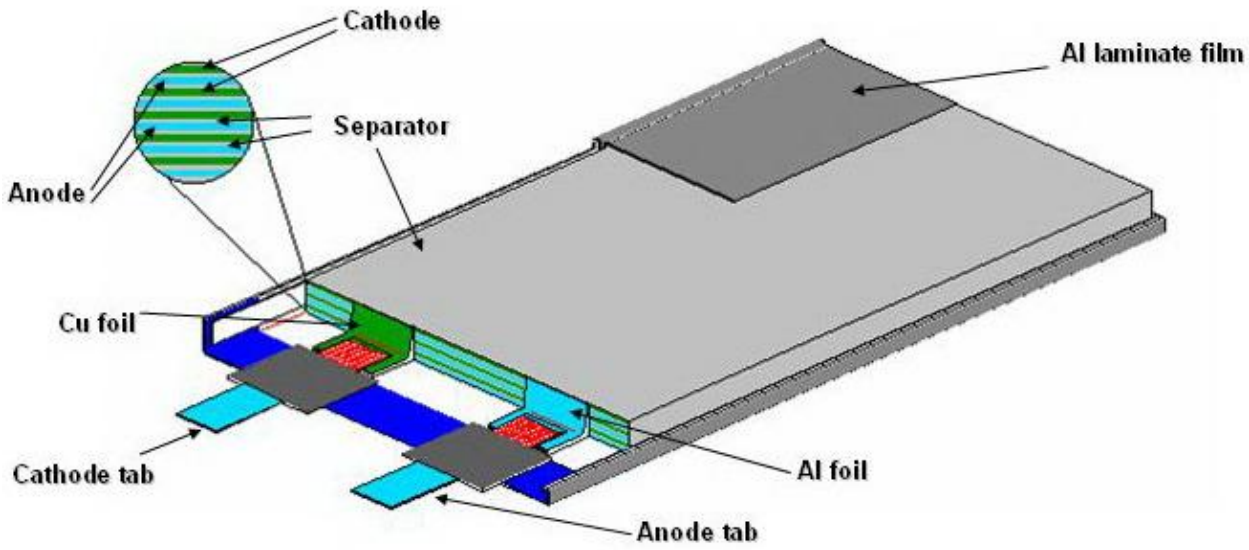
1. Anode LiC6 مصنوع من الكربون
2. Cathode LiCoO2 مصنوع من اكسيد كوبالت الليثيوم
3. العازل يتكون من شريحة رقيقة جدا من البلاستيك (يوضع هذا العازل بين الانود و الكاتود)
4. وهذا المحلول في الغالب هو electrolyte هذه الطبقات الثلاثة مغمورة في محلول يعمل عمل المحلل الكهربي الاثير Ether.

ملاحظة:

ضرورة وجود lithium في anode و وجود ion lithium في cathode + electrolyte

وعندما يتم شحن البطارية فإن ايونات الليثيوم تتحرك خلال محلول الاثير من الالكترود الموجب الى الالكترود السالب وتلتصق بالكربونز وعند استخدام البطارية فإن ايونات الليثيوم تتحرك في الاتجاه المعاكس من الكترود السالب حيث كانت على الكربون الى الالكترود الموجب.LiCoO2

Lithium foil (0-400$) /kilogram
Lithium ion foil (10-20$)/kilogram
Separator (1-4$)/square meter
Anode,cathode tab (0-10$)/piece
LiFePO4 (electrolyte) (10-50$)/ton
Aluminium laminate film (1-20$)/square meter

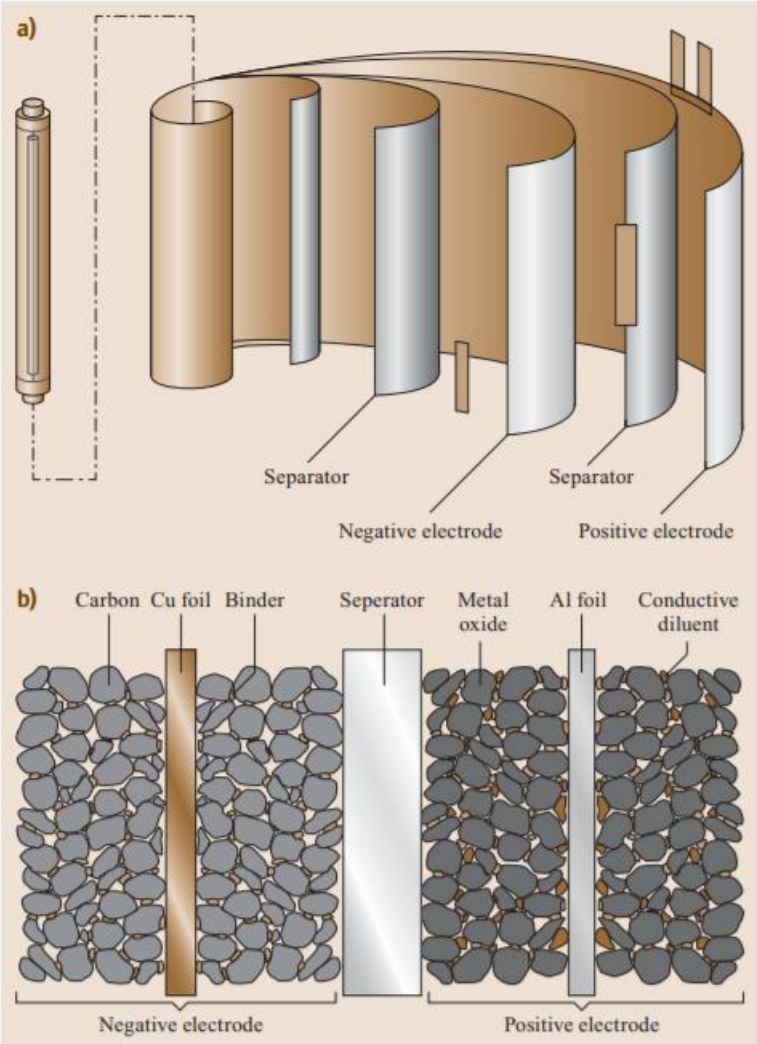



**Charge/Discharge Chemical Reaction**

$$LiCoO_2 + nC \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} Li_{1-x}CoO_2 + Li_xC_n$$

- خلايا الليثيوم ايون:

كما لكل بطارية غلاف خارجي لها فإن بطارية الليثيوم ايون تحاط بغلاف من المعدن وهذا الغلاف المعدني ضروري لان محتويات البطارية تكون عند ضعغط اعلى من الضغط الجوي. والغلاف يحتوي على امان خاص عندما ترتفع درجة حرارة البطارية ويزداد الضغط عن الحد المسموح به فإن فتحة صغيرة تفتح ليخرج منها الضغط الزائد. وتصبح البطارية بعد هذه الحالة عديمة الفائدة.



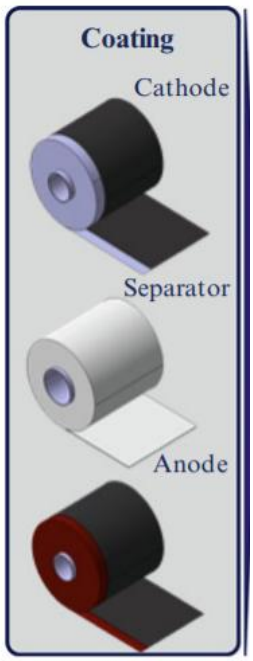

Copper (anode)

Aluminium (cathode)

## 3. Process to make the pouch cell lithium:

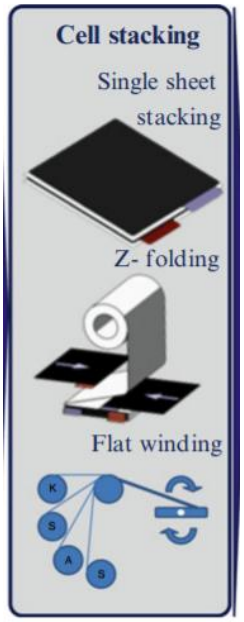
the procedure of assembling the materials to obtain a lithium cell is as follows:

1. **cutting the copper and aluminum foil**




2. **Tailoring**

3. **Stacking:**
    - a conductive carbon-coated copper foil for the anode
    - a separator
    - a conductive carbon-coated aluminum foil for the cathode
    - separator and so on until 5 anodes and 5 cathodes are separated by a separator

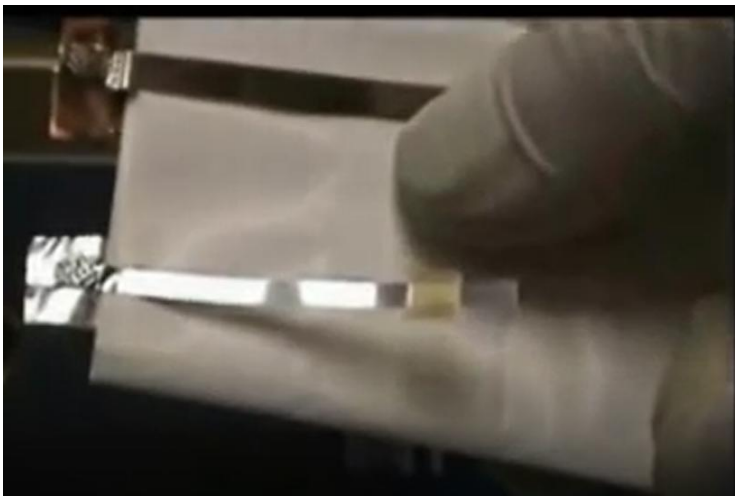



4. **Welding**

The pouch cell core is ready, the red one is Copper current collector for anode and the silver one is aluminum current collector for cathode:

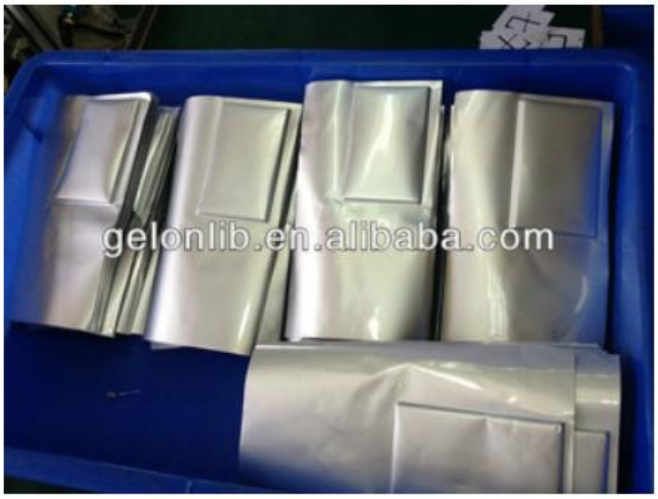
- Get nickel tab for Cu current collector
- The tab and the heat able polymer tape on it are placed before welding

- Welding for Al and Cu is finished

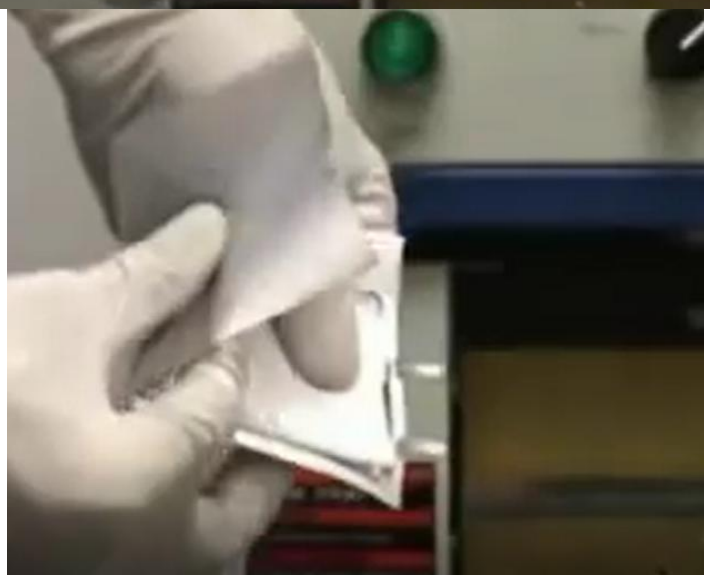


**5. Sealing**

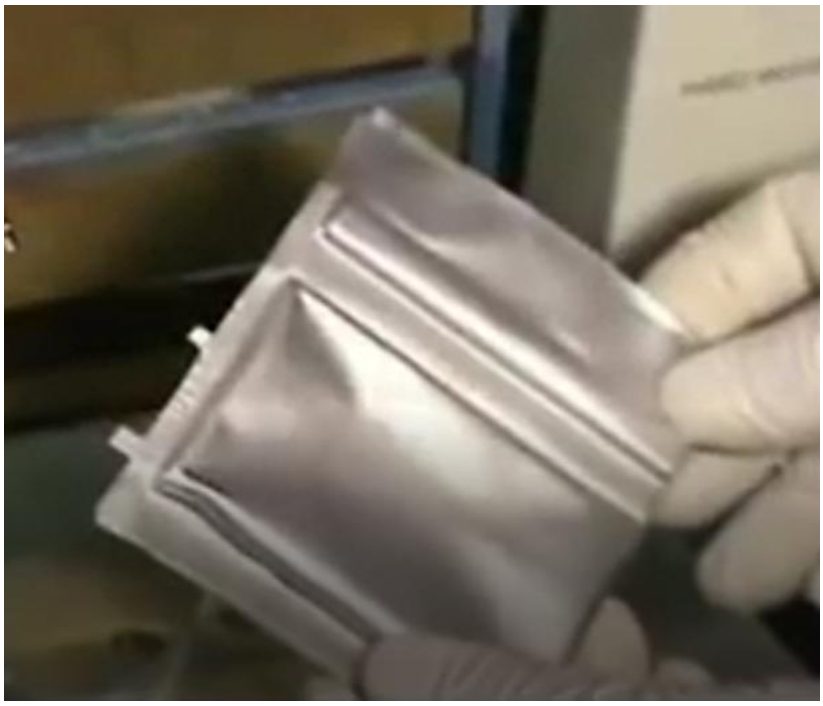
- Put the cell core with tab into the case formed (Aluminum laminated film)



- must keep the polymer tape right in between the Al laminated film



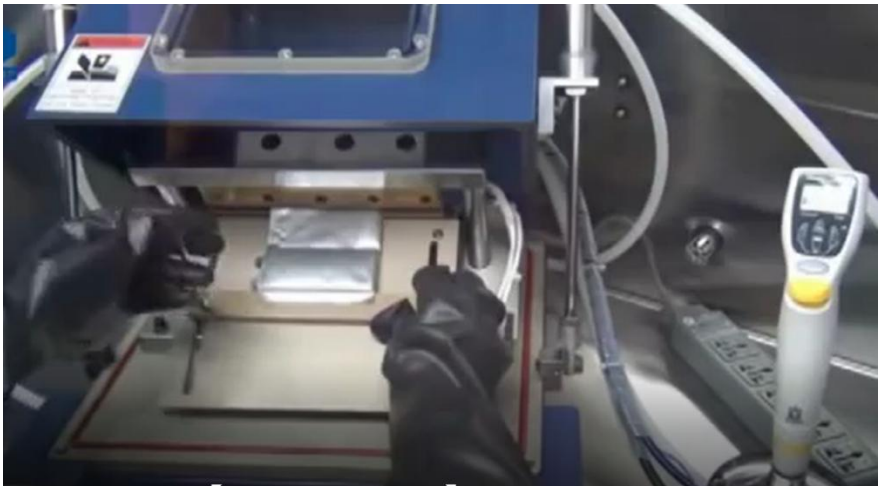
- Top side sealing is finished



Note: The battery has been sealed of three edges already by using the MSK-113A hot sealer.
The only one edge left is for electrolyte filling in and then we will seal this by vacuum sealer

- Now we are going to fill in the electrolyte, use an electrolyte filler.

- Put the battery on the sample stage of the sealer. We are going to make the temporary seal.
- Adjust the sample holder to make sure the edge fully into the sealing area.



- Now we have done the temporary seal. And the battery is ready for formation

**6. Formation**

Once the cell assembly is complete the cell must be put through at least one precisely controlled charge / discharge cycle to activate the working materials, transforming them into their useable form. Instead of the normal constant current - constant voltage charging curve, the charging process begins with a low voltage which builds up gradually. This is called the Formation Process. (Une fois l'assemblage de la cellule terminée, la cellule doit subir au moins un cycle de charge / décharge contrôlé avec précision pour activer les matériaux de travail, en les transformant en leur forme utilisable. Au lieu de la courbe de charge constante de courant constant - tension constante, le processus de charge commence par une tension basse qui s'accumule progressivement. C'est ce qu'on appelle le processus de formation.)

you can choose to use scissors to cut off the temporary sealed edge or use a needle to prick out several holes on it

After the formation and prick out several holes we do the final seal then cut off the extra

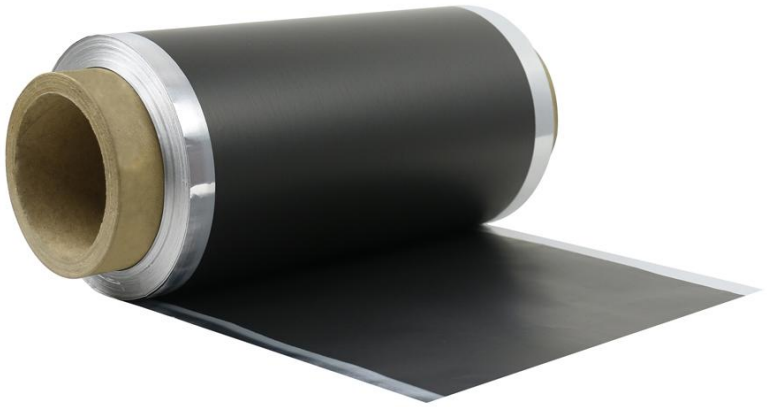
## 4. Data sheet of material

**Coated copper foil:**

| | |
|---|---|
| Conductive carbon coating | Double side coating with 1 micron thickness each side |
| Density | 0.54 g/m2 |
| Surface resistivity | < 30 ohms per 25um2 |
| Copper Purity | > 99.9% |
| Copper Thickness | 9 um |
| Coating Width | ~ 239 mm |
| Total Width | 280 mm |

**Coated aluminum foil:**

| | |
|---|---|
| Conductive carbon coating | Double side coating with 1 micron thickness each side |
| Density | 0.5 g/m2 |
| Surface resistivity | < 30 ohms per 25um2 |
| Aluminum foil purity | > 99.9% |
| Aluminum foil Thick ness | 16 micron |
| Coating Width | ~ 200 mm |
| Total Width | 260 mm |



**Separator:**

| | |
|---|---|
| Nominal Voltage | 4.5V |
| Nominal Capacity | 800mAh |
| Type | Li-Ion |

**Laminated aluminum film:**

| layer material | thickness |
|---|---|
| Nylon | 25 micron |
| DL | 3 micron |
| Aluminum | 40 micron |
| EL | 15 micron |
| PP | 30 micro |
| width | 400 mm |
| thickness | 133 micron |

**Electrolyte:**

| | |
|---|---|
| Electrolyte Salt | 1 mol/L LiPF6 |
| Organic Solvent | EC+DMC+DEC; 1:1:1 in volume |
| Net weight | 4 lbs |
| Max. Voltage | 4.5V |
| Chromaticity | <50 Hazen |
| Moisture | ≤20ppm |
| Free Acid (HF) | ≤50ppm |
| Density | 1.20±0.03g/ml @ 25$^{o}$C |
| Electrical Conductivity | 7.4±0.5mS/cm |
| Chlorine (Cl) | <1ppm |
| Sulfate (SO4) | <10ppm |
| Potassium (K) | <10ppm |
| Sodium (Na) | <10ppm |
| Calcium (Ca) | <10ppm |
| Iron (Fe) | <6ppm |
| Lead (Pb) | <5ppm |

**Nickel tab:**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## 5. Cost of material

| Material | Quantity | Dimension | Cost ($) | Total cost ($) |
|---|---|---|---|---|
| **Coated copper foil** | 1.3 Kg/roll | width: 280 mm | 230 $ | **620 $** |
| **Aluminum coated foil** | 1.5 kg/roll | 30 m2 length : 120 m | 210 $ | |
| **Separator** | 1 m2 | w: 300 mm T: 120 mm | 18 $ | |
| **Laminated aluminum film** | 1 m2 | W : 400 mm T: 133 um | 12 $ | |
| **Electrolyte** | 1 kg | | 140 $ | |
| **Nickel tab** | 10 pairs | w: 4 mm | 10 $ | |

| other supplier (top machine) | Quantity | dimension | cost($) | total cost($) |
|---|---|---|---|---|
| **Coated copper foil** | 1 piece (A4 210*297) --> 6$<br>3 pieces --> 3*6 = 18 $ | Width: 250mm<br>Thickness: 0.01mm<br>Length: 50m | 18 | **44.5** |
| **Aluminum coated foil** | 1 piece (A4) --> 5$<br>3 pieces --> 3*5 = 15 $ | Width: 426mm<br>Thickness: 0.015mm<br>Length: 100 m | 15 | |
| **Separator** | 1.5 $ / M2 we need 1 M2 | Width: 215 mm<br>Thickness: 25 um<br>Length: 1000 m | 1.5 | |
| **Laminated aluminum film** | 20 $ / M2 we need 1 M2 | Width: 400 mm<br>Thickness: 152 um<br>Length: 250 m | | |
| **Nickel tab** | 10 pairs | Width : 50 mm | 10 | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

TODO simulation battery model with tool DWSIM

## 6. **FreeCad**

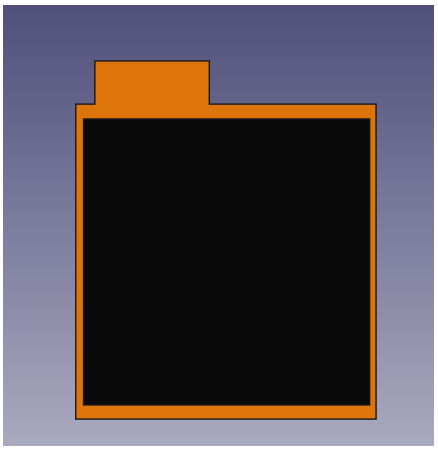


*Figure 1: Anode*

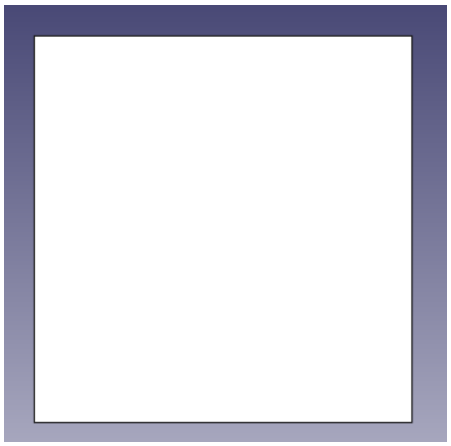


*Figure 3: Separator*

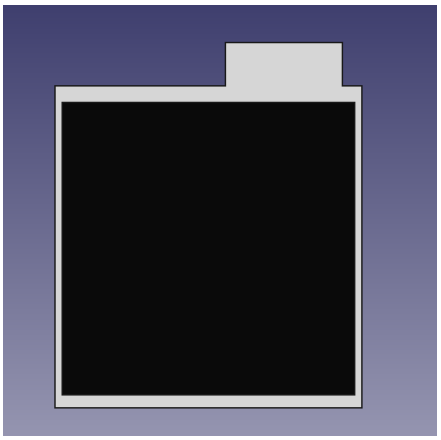


*Figure 2: Cathode*

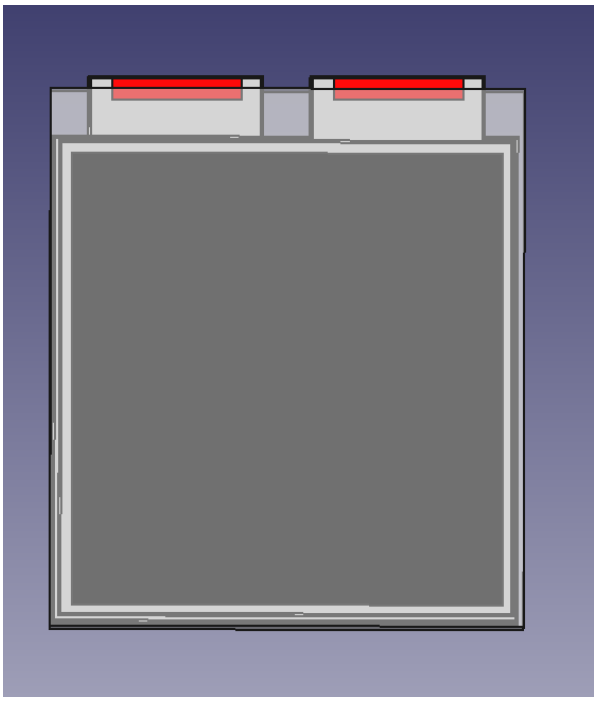
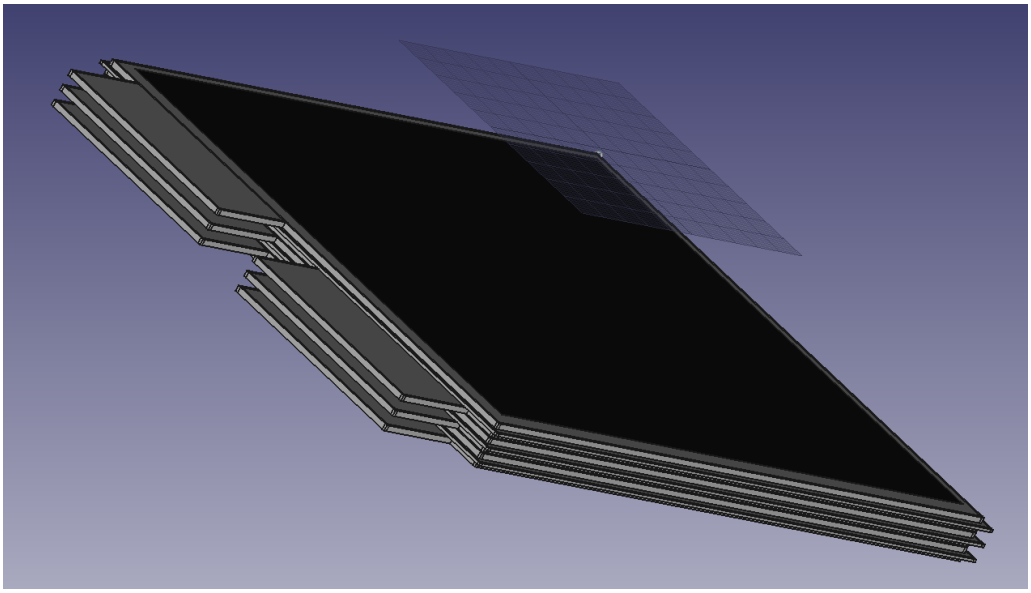
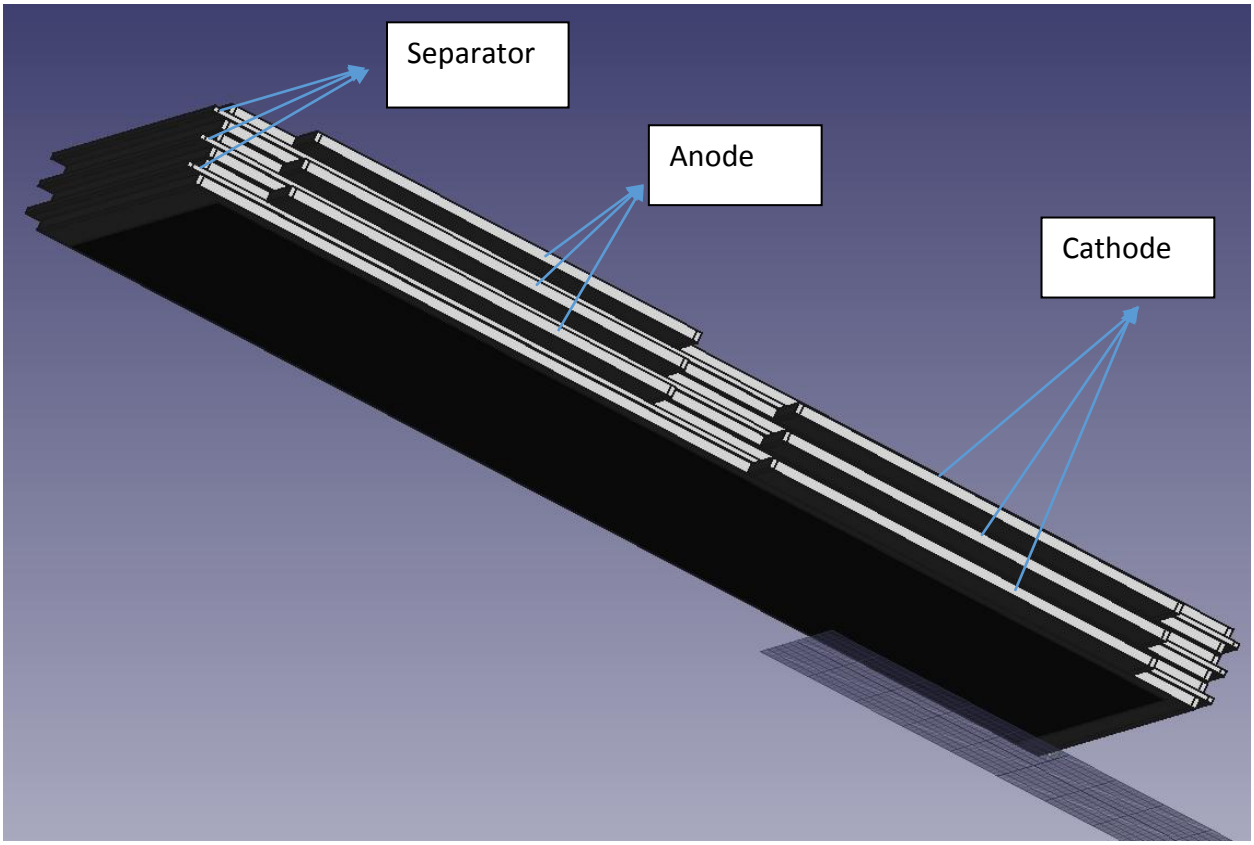
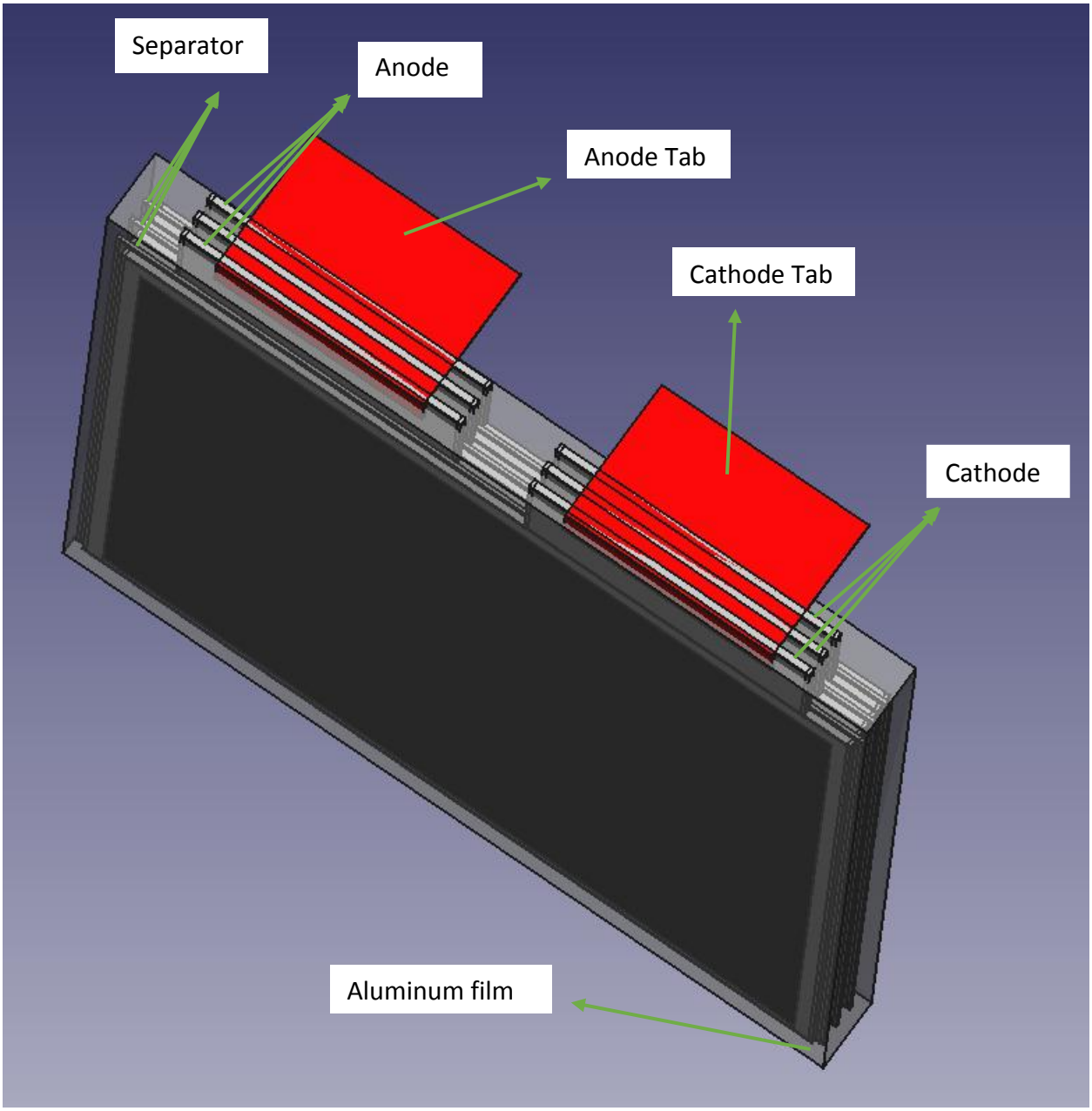
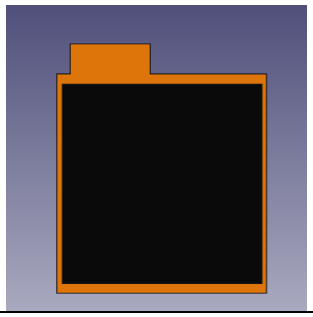
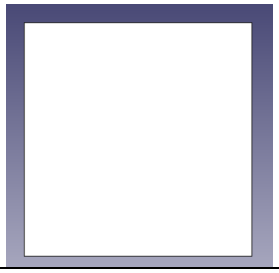
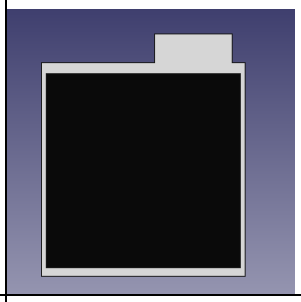
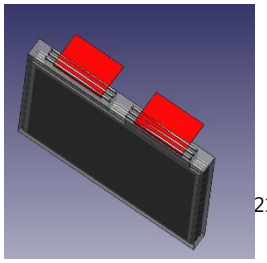


*Figure 4: Assemble of material lithium cell*




Separator
Anode
Cathode


Separator
Anode
Anode Tab
Cathode Tab
Cathode
Aluminum film

| | |
|---|---|
| Anode |  29112017_anode.FCStd |
| separator |  29112017_separator.FCStd |
| Cathode |  29112017_cathod.FCStd |
| Assemble of material cell |  2122017_Libatt.FCStd |