

Lecture 4C: Batteries

Module #1

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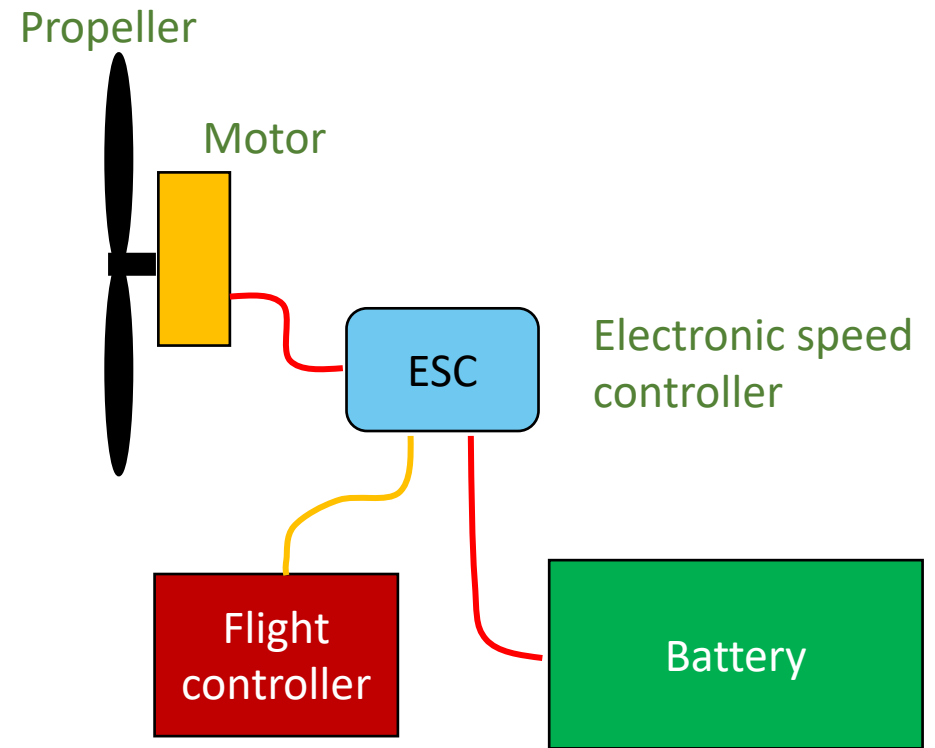
In this lecture you will learn:

- The fundamentals of converting stored energy into thrust
- The elements of a propulsion system

Most propulsion system for drones are based on lithium polymer battery technology

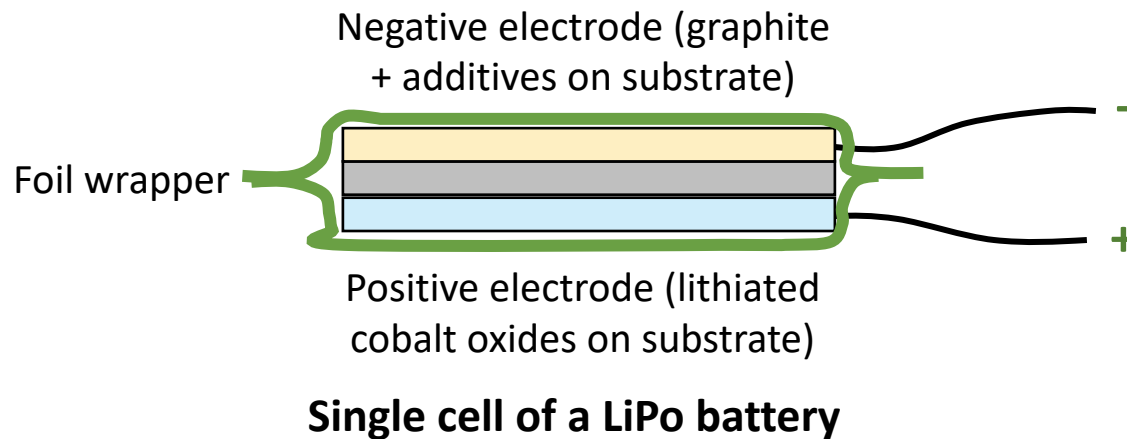
Batteries
1. Design
2. Selection
3. Care

- The main elements of a propulsion system include:
 - Propellers
 - Motors
 - Speed controllers
 - Batteries
 - Sensors (feedback and health monitoring)



VTOL propulsion: Batteries

- Battery technology today is significantly better than just a few years ago, however with the advances in performance comes some risks
- The common battery used in drones is a Lithium Polymer (LiPo) battery design



Each cell of a LiPo battery is contained in a soft aluminum pouch, allowing for battery expansion during charge and discharge cycles (up to 10% dimensional change)



A single LiPo battery cell has a nominal voltage of 3.7V

VTOL propulsion: Batteries

- A single LiPo cell will have a nominal (average voltage) of **3.7V (50% discharge)**
 - The lowest voltage that battery should experience is **3.0V**, and the highest voltage from charging should be **4.2V**
- A battery rated at **7.4V** is comprised of **two cells (2) wired in series (S)**
 - A **2S** battery has two cells in series (**7.4V**), a **3S** battery has 3 cells in series (**11.1V**)
- Batteries are also classified by their "C" rating - the EcoSoar battery is a 5200 mAh, 3S, 10 C battery



VTOL propulsion: Batteries

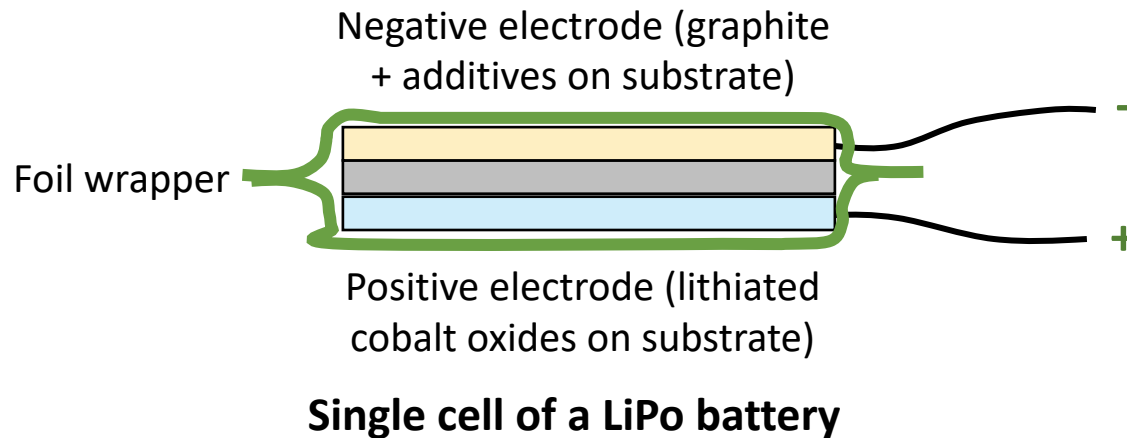
- The C rating indicates the maximum safe continuous discharge for the battery
- If the battery is a 10C battery and it is rated at 5200 mAh (5.2Ahr), then the max safe continuous current would be $10 \times 5.2\text{A} = 52\text{ Amps}$
- Some batteries also come with a burst rating, which would be the allowable current draw for short periods of time, like 10 sec



Battery care: management, storage and transportation

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Battery care: management, storage and transportation

Batteries

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- Battery voltages are important to regulate as they can impact the life of the battery
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Protection electronics are required with these batteries!

- *To avoid charging above the max value*
- *To avoid discharge below min value*
- *To avoid excessive discharge*

Battery care: management, storage and transportation

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- Charging systems typically have built-in safeguards to protect the battery:
 - Overload, overvoltage and temperature protections are common
 - Cell balancing avoids an unstable charging process which could lead to overheating - this is accomplished through monitoring by connecting to the balancing leads on the battery
- The charger output needs to be matched to the battery type (2S, etc)
- All battery charging stations should be operated in fire-safe environments because the risk of battery fire is elevated during charging



Battery care: management, storage and transportation

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- Fire safety is critically important when LiPo batteries are being used
 - Charging should not occur unattended - ***no overnight charging!***
 - Batteries that become “puffy” (greater than 10% dimensional change) are probably damaged due to improper charging/discharging. ***Take them out of service***
 - Batteries should be stored in fireproof containers or at a minimum, in non-combustible areas
 - A container of sand should be near the battery charging station to put fires out
 - **Water is not used on a battery (chemical) fire**



<http://instructables.com>

Battery care: management, storage and transportation

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- Similar to storage, the LiPo battery should be transported in a fireproof container, or at the least, kept away from flammable articles
- The leads on a LiPo battery should be protected when not in use to minimize the likelihood of a short circuit
- Batteries should not be transported in close proximity to each other - if one overheats it may cause the others to spontaneously overheat as well
- Always keep a multimeter or cell checker nearby to check the state of charge of the battery

