

# Lecture 4C: Batteries

Module #1

Lecture Presented By: Kevin Kochersberger

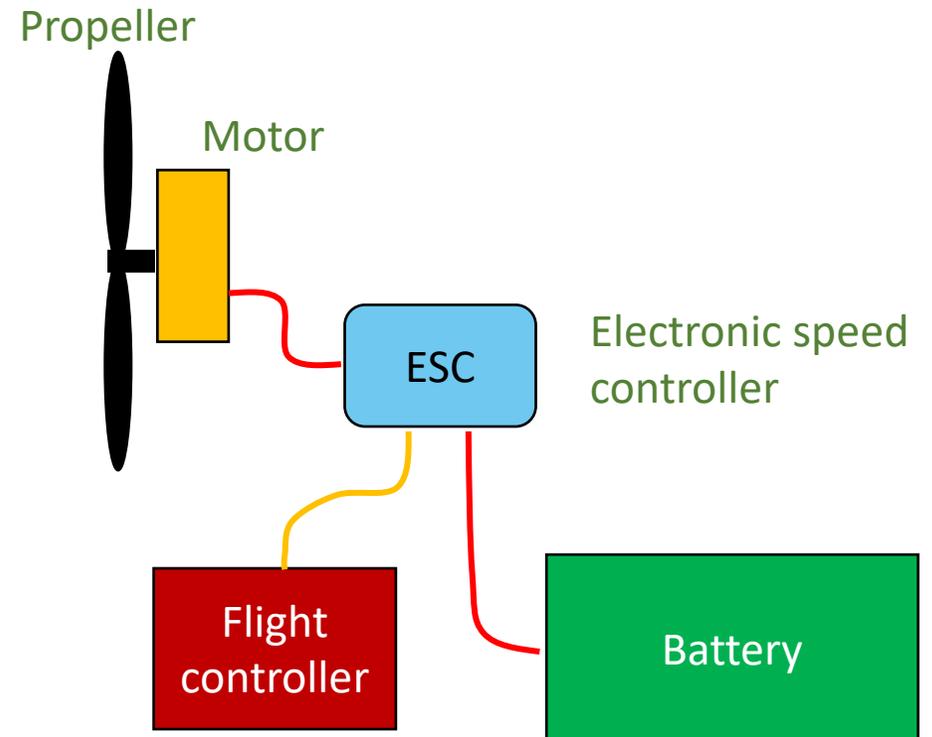
In this lecture you will learn:

- 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

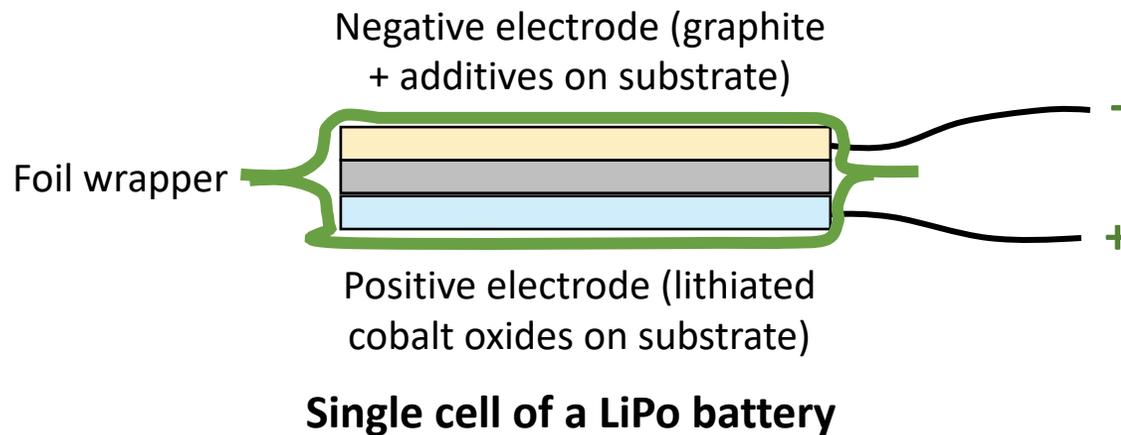
Batteries  
1. Design  
2. Selection  
3. Care

- 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



- Batteries
1. Design
  2. **Selection**
  3. Care

# VTOL propulsion: Batteries

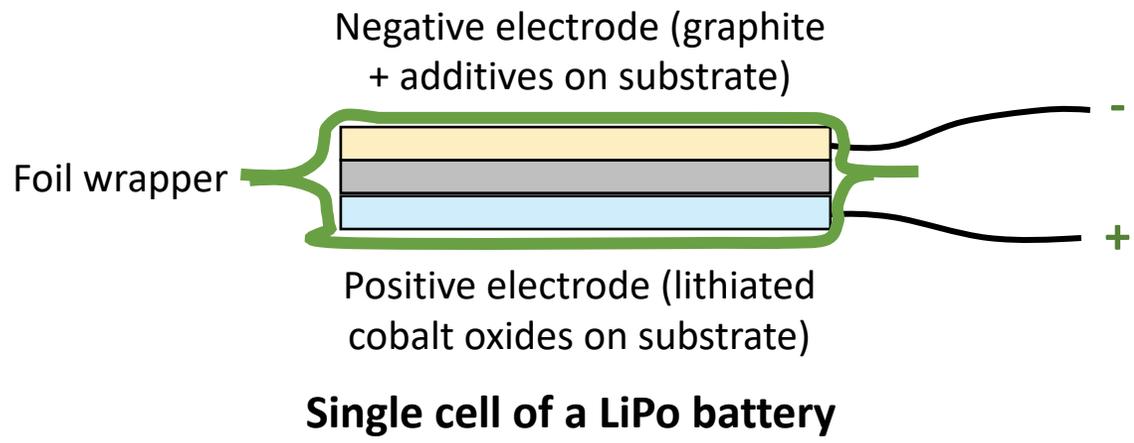
- The C rating indicates the maximum safe continuous discharge for the battery
- If the battery is a 10C battery and it is rated at 5200 mAh (5.2Ahr), then the max safe continuous current would be  $10 \times 5.2A = 52 \text{ Amps}$
- Some batteries also come with a burst rating, which would be the allowable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



- Batteries
1. Design
  2. Selection
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# Battery care: management, storage and transportation

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# Battery care: management, storage and transportation

- Battery voltages are important to regulate as they can impact the life of the battery
  - 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)**
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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

Batteries  
1. Design  
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3. Care

- 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

## Batteries

1. Design
2. Selection
3. Care

- 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

## Batteries

1. Design
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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

