

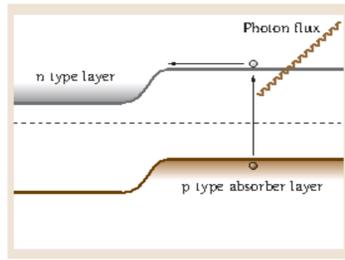


# GALLIUM ARSENIDE SOLAR CELLS ON UNMANNED AERIAL VEHICLES AND THEIR IMPLICATION IN THE MILITARY

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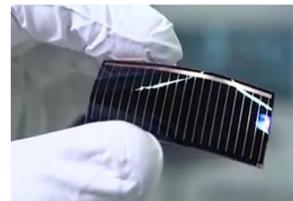
## How Solar Cells Work

- Solar cells convert sunlight to electricity using semiconductor materials
- Photons from sunlight strike the semiconductor. If the photon has a high enough energy of impact, it excites an electron
- The electron travels across a gap in the semiconductor to a region where its energy is captured (shown below)
- Solar cells have a maximum theoretical energy efficiency of 33.5%
- Solar energy is a popular source of renewable energy



## Gallium Arsenide Solar Cells

- They are made using the semiconductor gallium arsenide (GaAs)
- GaAs solar cells are advantageous compared to more traditional silicon solar cells for many reasons:
  - Lightweight – they do not weight UAVs down
  - Flexible – they are easy to affix to UAVs
  - Energy efficient – they generate higher amounts of energy compared to silicon solar cells
  - Weather resistant – they are less susceptible to damage from wind and ultraviolet radiation
- Alta Devices, a California based company focused on producing solar panels, developed a GaAs solar cell with a record 29.1% efficiency (shown to the right)



## Unmanned Aerial Vehicles and the SBXC Sailplane

- Unmanned aerial vehicles (UAVs) are any type of aircraft that does not have an onboard human pilot
- They are used for purposes such as photography, search and rescue missions, and in the military
- The Naval Research Laboratory modified the company RnR's model SBXC Sailplane with GaAs solar cells from Alta Devices
- Flight time increased from 4 hours with only battery power to 11.2 hours with GaAs solar cells (wing with Alta Devices cells shown to right)
- Alta Devices' solar cells were the easiest to attach to the sailplane compared to other cells



## Application to Drones in the Military

- Drones in the military are used in intelligence, surveillance, and reconnaissance missions to gather information about the enemy. They are also weaponized with missiles
- With, single junction GaAs solar cells on weaponized drones, drones will be able to fly for longer periods of time or carry larger payloads (i.e. missiles)
- Operators can survey situations for extended periods of time, thus ensuring they have the right target
- Current development on resupply drones may allow future drones to bring supplies to troops on the dangerous front lines
- GaAs solar cells would allow such drones to carry more supplies a farther distance



## Ethics and Sustainability

- Military drones allow for precision targeting that minimizes casualties in theory
- Due to the nature of the job, this is not always the case. Strikes are sometimes conducted on targets that fit the profile of an enemy. Thus, civilian casualties still occur, though the aim is to minimize them
- On military drones, or drones of any kind, solar panels would be sustainable by replacing batteries that are made from toxic chemicals, which harm the environment upon disposal by polluting water and soil
- In a broader sense, solar panels are sustainable because they provide clean energy and replace harmful nonrenewable energy sources, such as fossil fuels
- To minimize the negative effects in drone warfare, one needs to think sustainably, seeing through a broad viewpoint that acknowledges the positive and negative consequences that actions have across all people, society, and future generations



Image showing the modified SBXC sailplane constructed by the Naval Research Laboratory