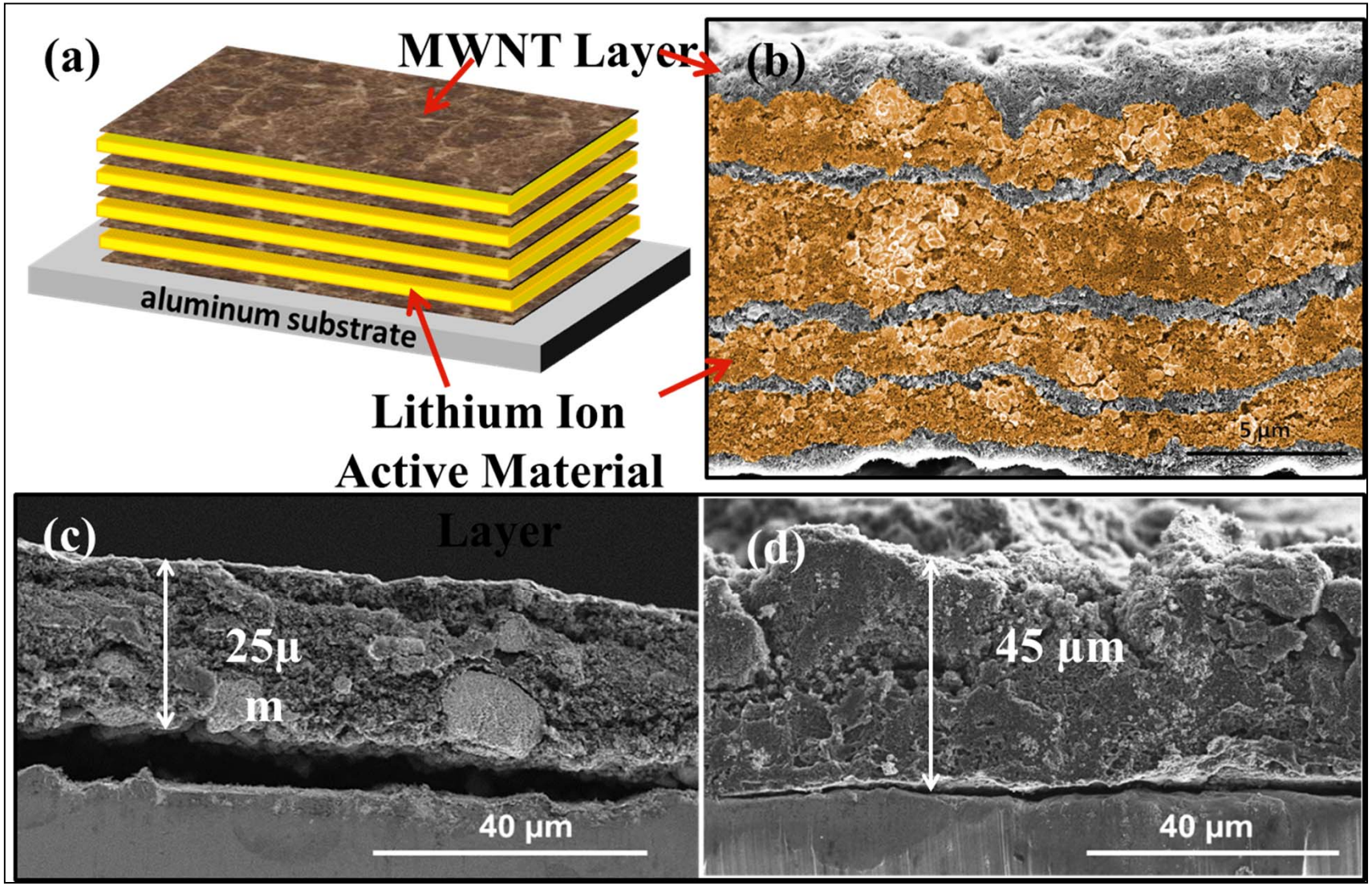
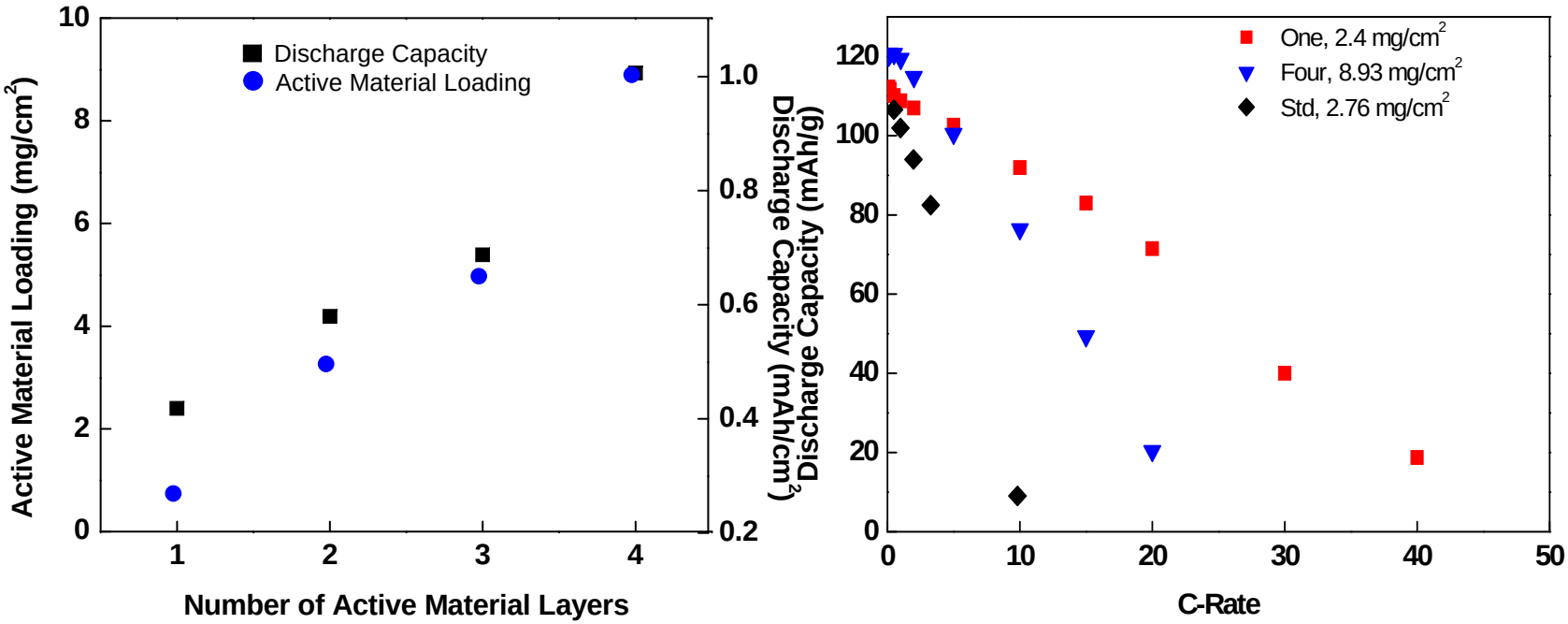
Electrode Architectures for High power density Li-ion batteries

Electrode Architecture

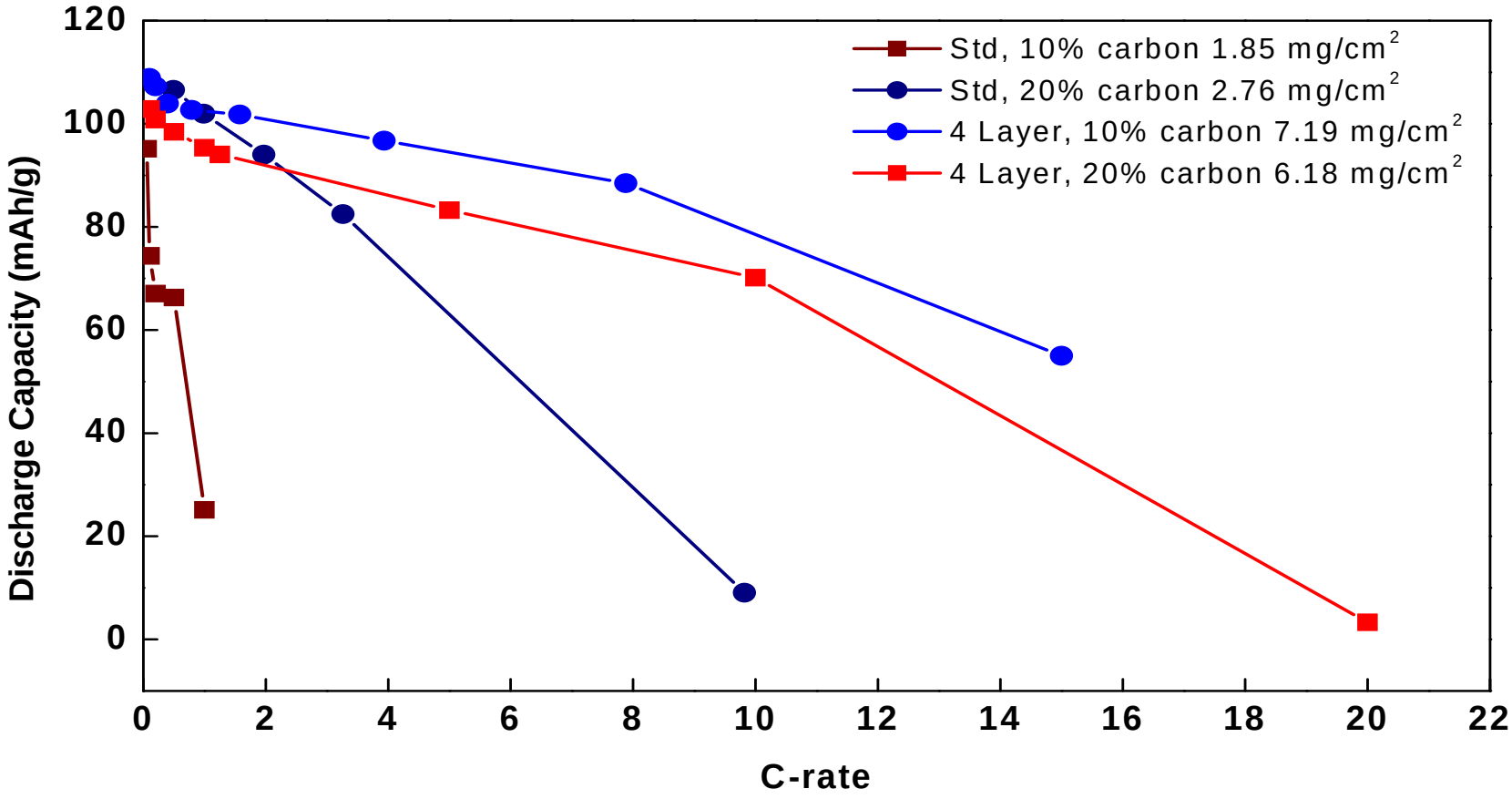


Electrochemical Testing



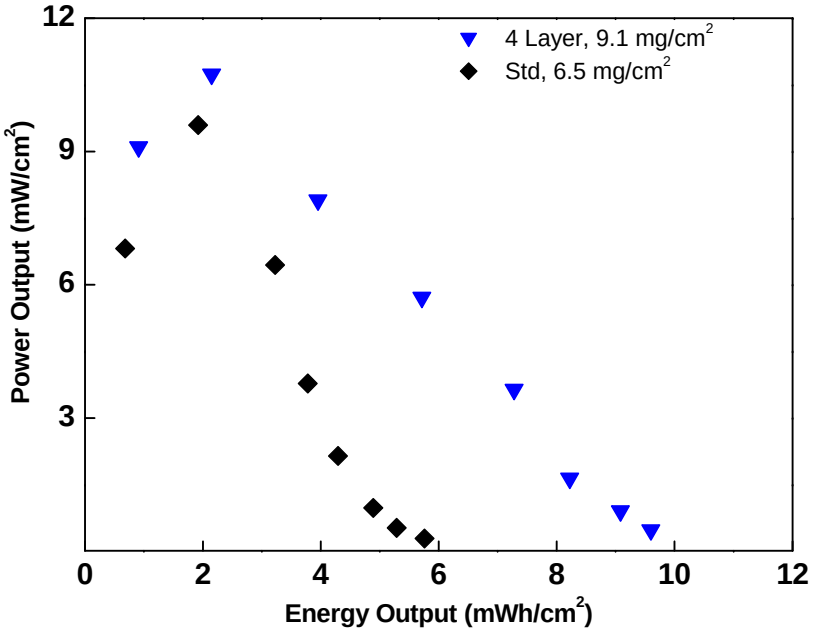
Uniform Increase in loading➔ Had minimal impact on the C-rate

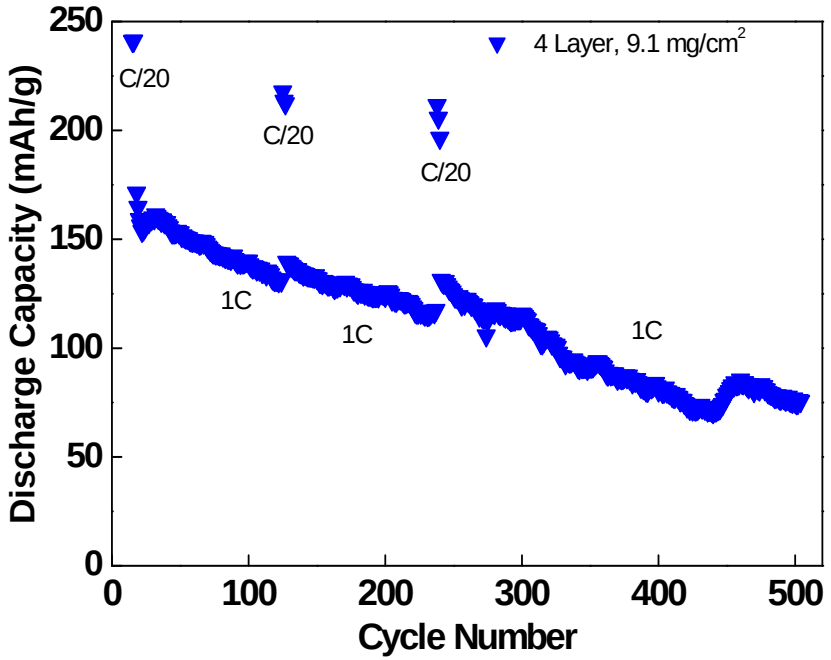
Effect of Electrode composition



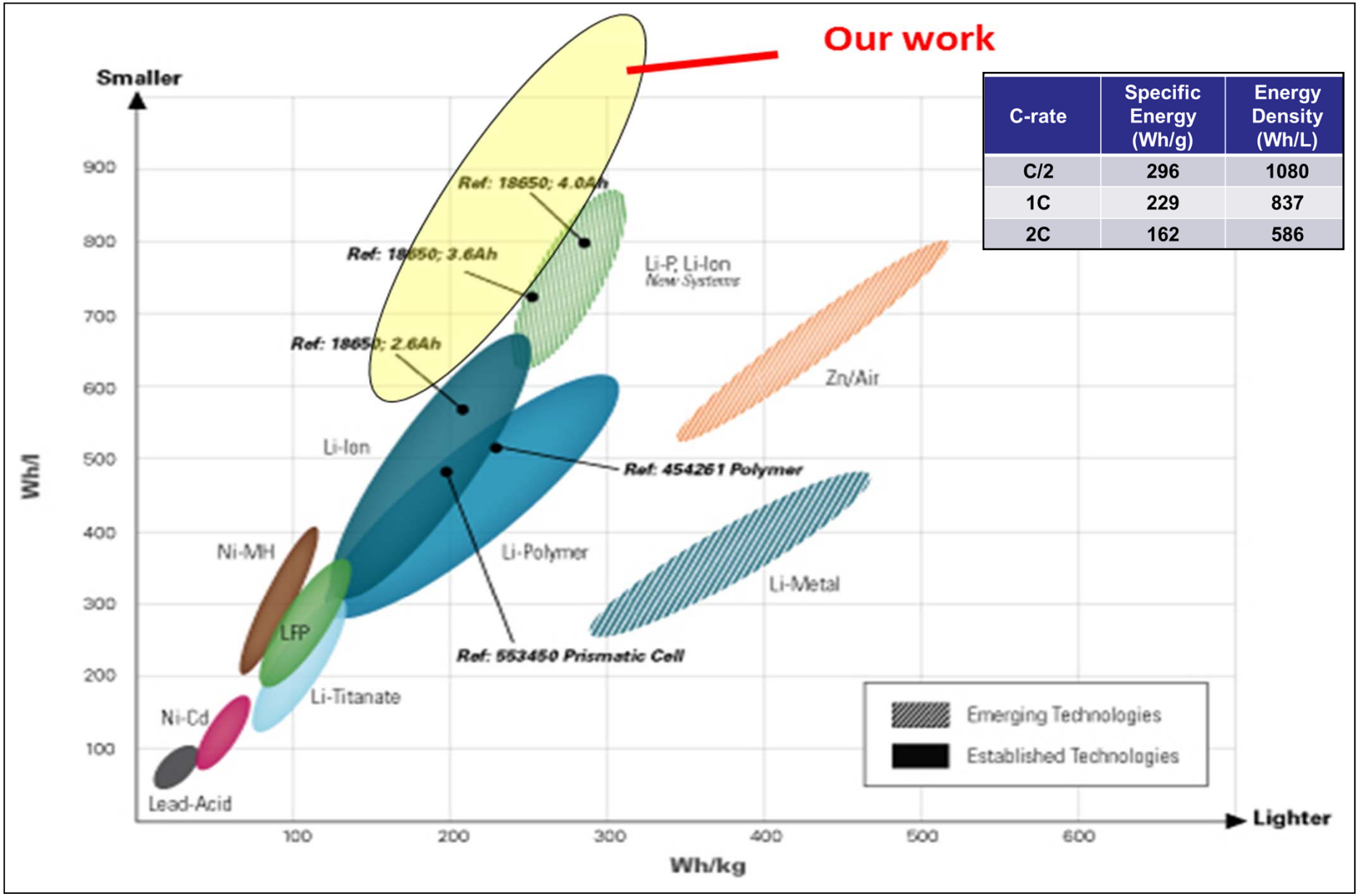
With low rate material

Layered- layered Oxide active material





Comparision



C-rate	Specific Energy (Wh/g)	Energy Density (Wh/L)
C/2	296	1080
1C	229	837
2C	162	586

Energy Harvesting from Infrared Sources

Need

Modern day smart soldier

- Needs a continuous source of energy for various electronics, communication and sensing devices.
- Need to carry less heavy batteries and reduce the warfighter's load.
- Other energy harvesters are either heavy or cannot provide the needed power.
- Thin film organic photovoltaic cannot provide power in the absence of sunlight (e.g. nighttime cloudy days etc.).

➔ A light weight flexible device capable of harvesting energy continuously and producing enough power to properly power various portable devices.

Objectives & Advantages

Objectives:

- To harvest energy at any time even in the absence of sunlight.
- To harvest energy from any heat source
- To harvest energy from sunlight complementing solar cells.

Advantages:

- Extremely lightweight
- Flexible
- Easily incorporated into fabrics
- Low manufacturing cost

Application:

- Remote operations
- Emergency situations
- Stand alone operations

Sources of infra red

Daytime sunlight

Human Body

Manmade

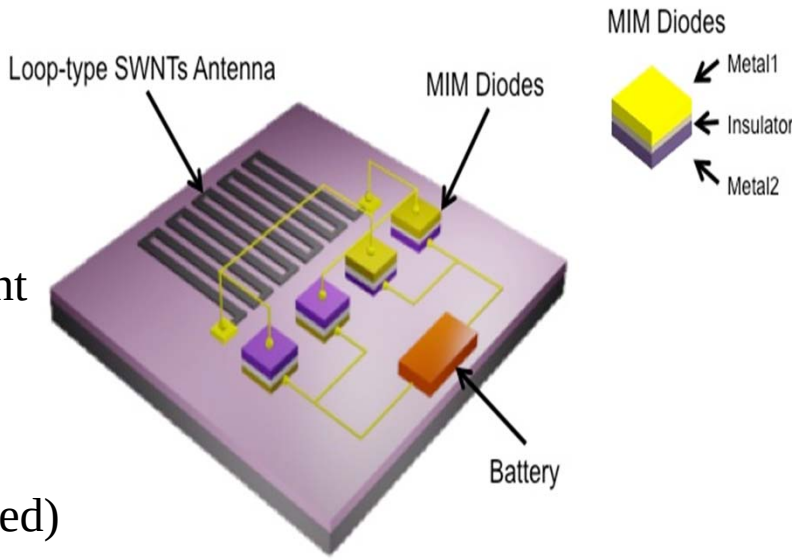
Microprocessor

Vegetation Nighttime

Infra red Antenna – Barriers

Antenna:

- Excellent resonance (>80%) in the desired frequency range (300GHz-450THz)
- Choice of materials need to exhibit very low electronic transition when coupling to the incident photon (reduced loss)
- Needs Nano-micro scale features to address the desired frequency range
- Low electron phonon coupling (low heat generated)



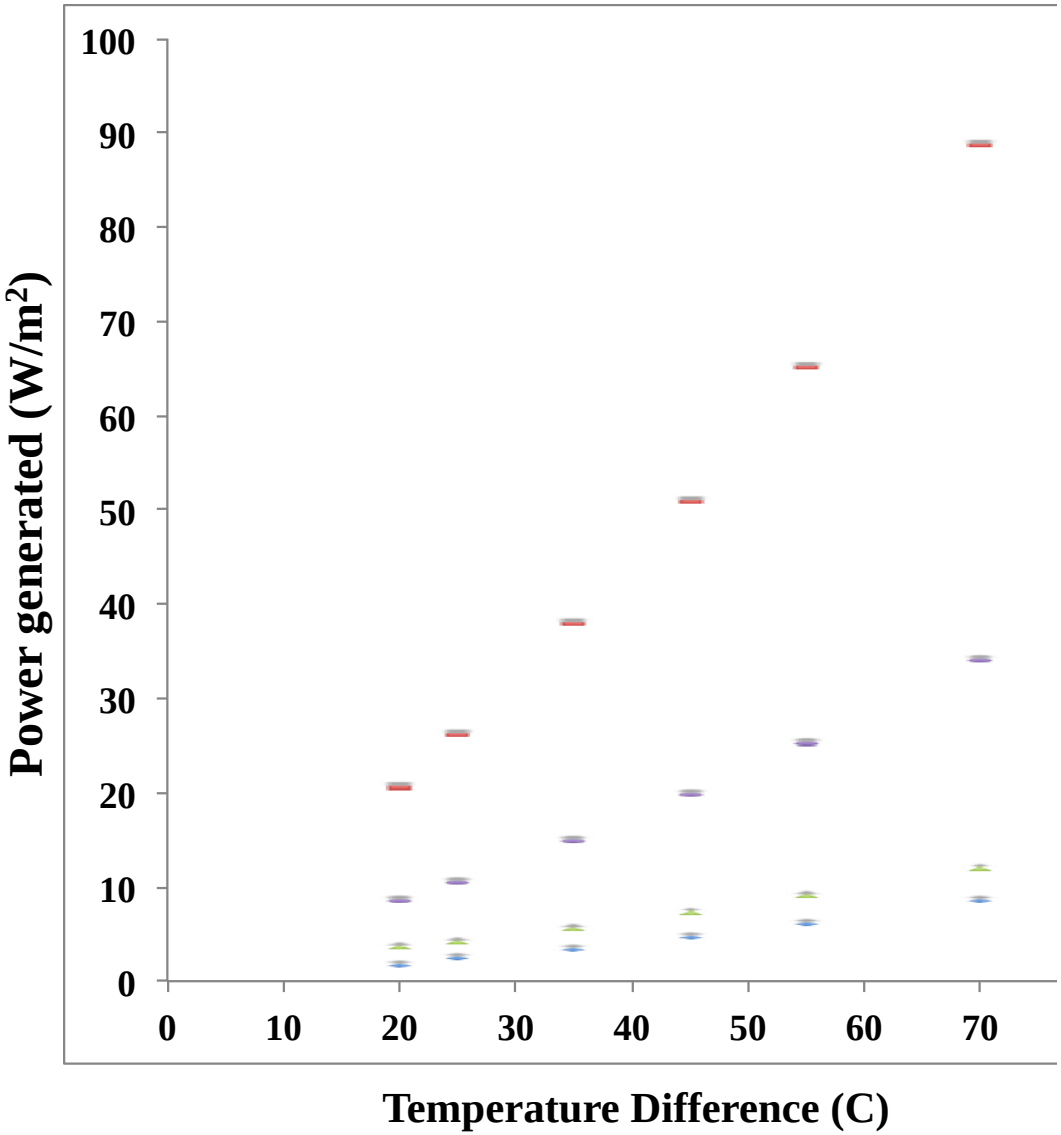
Rectifier circuit:

- Needed diodes operating in the 300GHz-450THz range with efficiency >80%
  - ➔ There are no diodes available commercially in that range.
  - ➔ Research efforts are very limited.
- Low cost manufacturing method to address cost effectiveness.

Coupling circuit:

- Needed to have ~90% coupling efficiency.
- Current couplers have not been tested in the desired frequency range

How Does it Compare with Thermoelectric Harvester

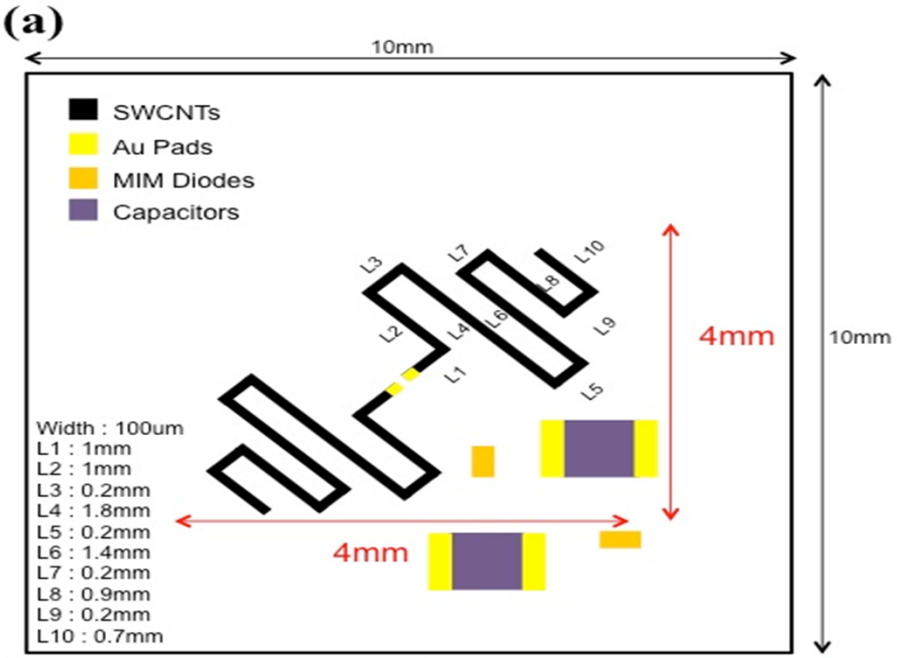


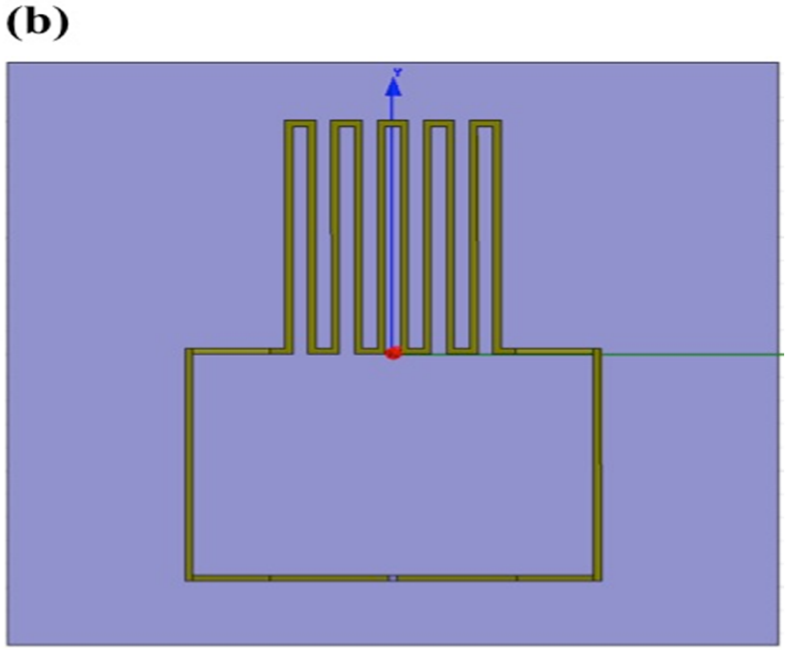
- Using diodes with theoretical limit (80% efficiency)
- Using diodes in research (30% efficiency)
- Using commercially available W band diodes(10% efficiency)
- Thermoelctric

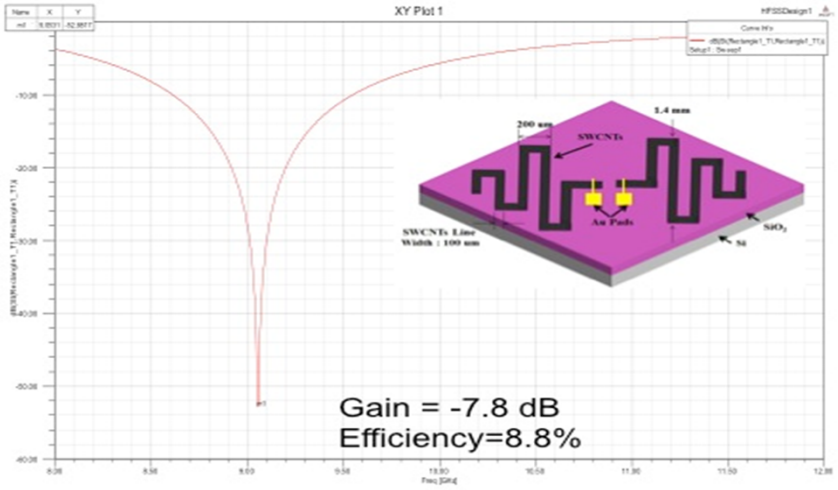
Assumptions:

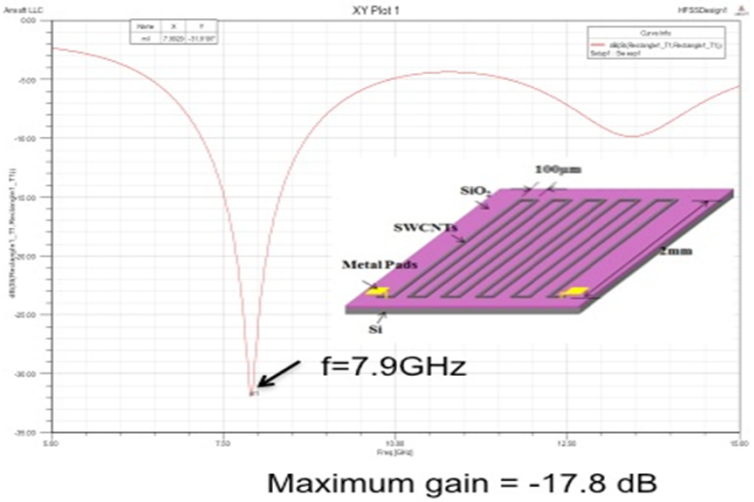
- Sink is at room temperature
- (20 C)
- Area of coverage for the rectenna: 60%
- Area of coverage for the Thermo-electric: 100%
- Load resistance: 250 Ohms

Design & Simulation





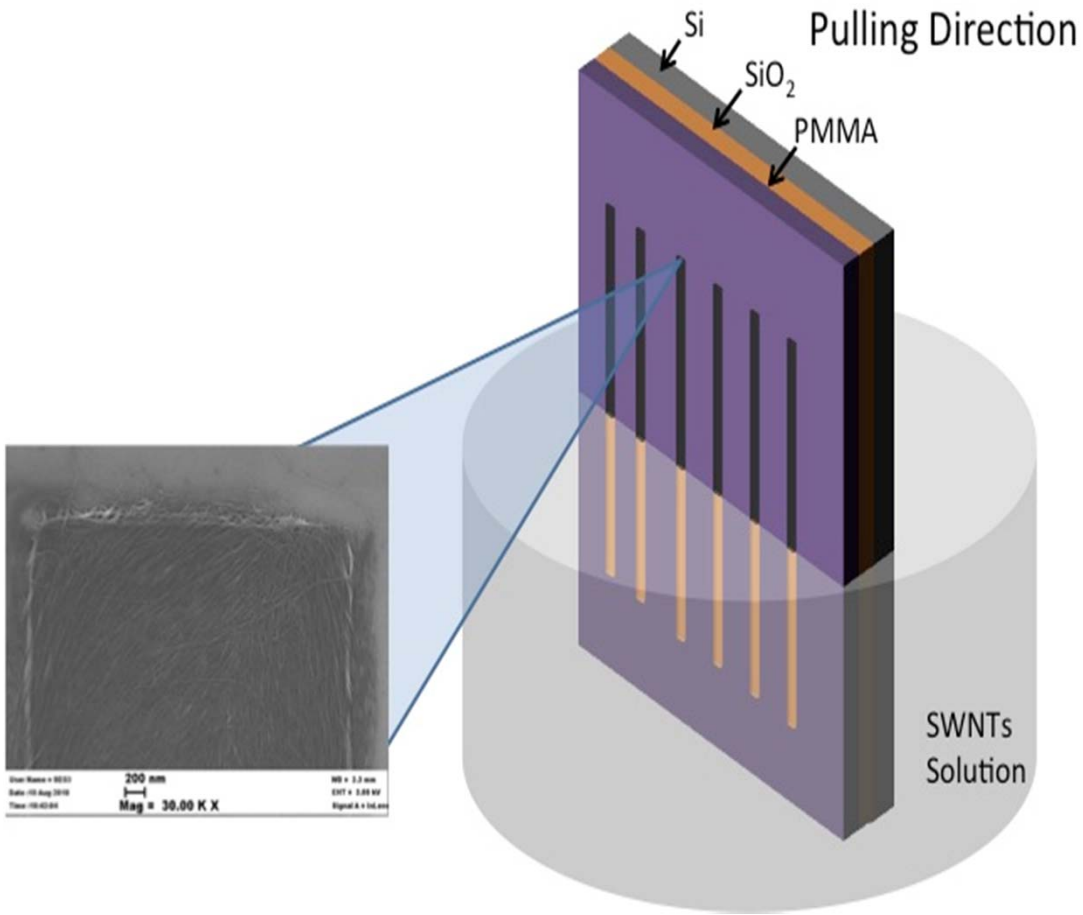


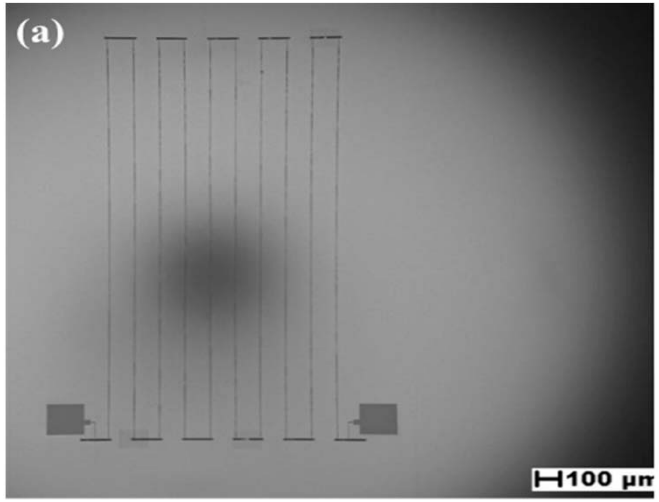


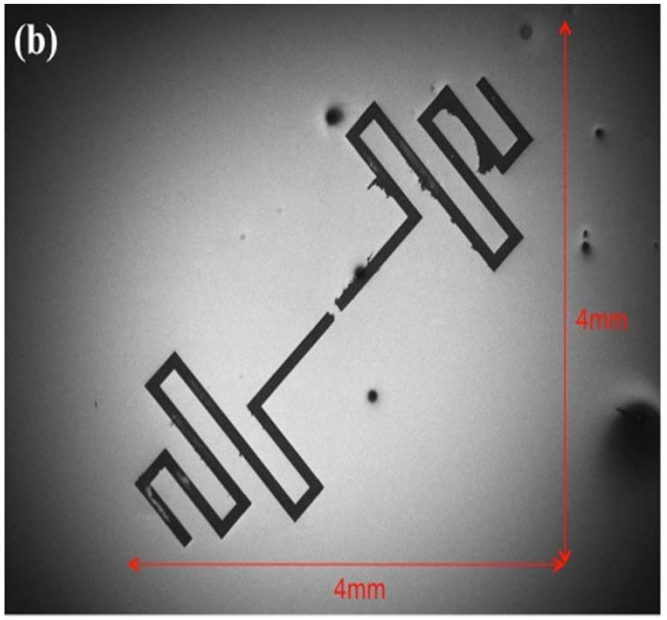
Maximum gain = -17.8 dB

Antenna Fabrication

Fluidic assembly is employed

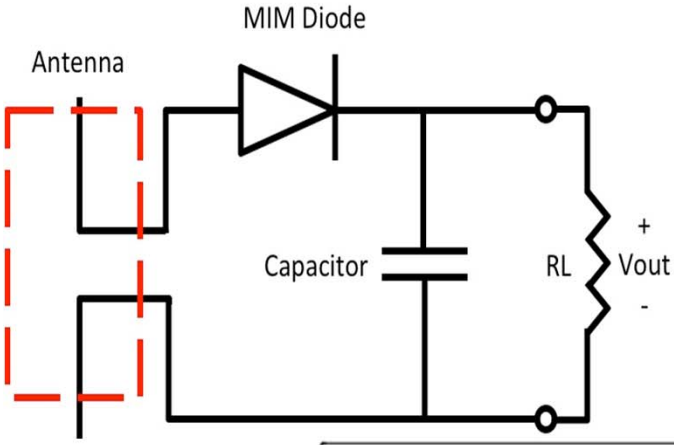




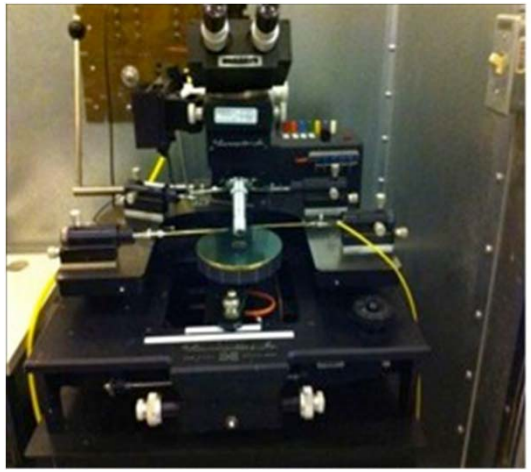


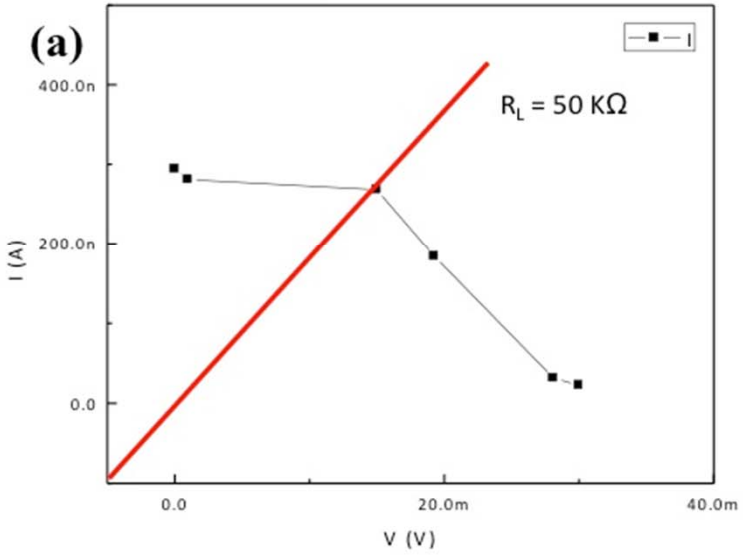
Testing with Commercial W band (30GHz) diodes

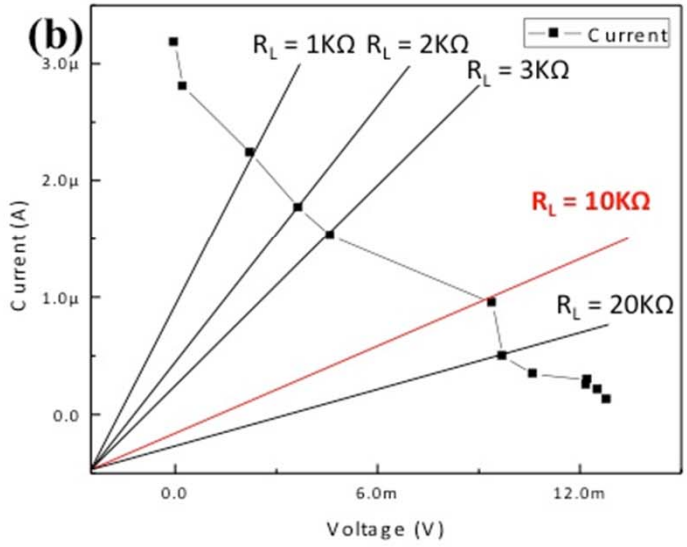
Circuit employed



Testing setup







➔ Energy harvested was several hundreds of Nano watts