**Introduction**

- III-V nanowire solar cells are third generation solar cells utilizing semiconductor nanowires that have excellent light trapping properties.
- To reduce the shadow losses and maximize the light absorbed by the cells, an optimal front contact should have high transmittance, high conductivity, and form a low resistance ohmic contact with nanowires.
- Ni/Ge/Au is a traditional contact layer for n-GaAs thin film devices due to its good performance in forming ohmic contacts with n-GaAs.
- Indium tin oxide (ITO) has high transmittance and low sheet resistance, which makes it an ideal material for front contacts in high efficiency nanowire solar cells.
- Performances of both Ni/Ge/Au and ITO contact on nanowire arrays are measured in our work.

**Device fabrication**

- In our work, III-V semiconductor nanowires were grown by molecular beam epitaxy (MBE). Devices were fabricated to estimate the contact resistance to the nanowires.
- Gaps between nanowires were filled with transparent planar cyclotene to support the contacting layer.

**Theory**

In the model, a series resistance ($R_s$) below 10 Ω gives a high fill factor.

- The series resistance mainly comes from the metal/semiconductor interface for highly doped semiconductors. Model shows a specific contact resistance ($r_c$) below 3 Ω·cm² gives a high fill factor and efficiency degrades fast when $r_c > 3$ Ω·cm².

**Results**

- ITO thin film was deposited by rf sputtering.
- ITO thickness: 500nm.
- ITO could form an ohmic contact with $5 \times 10^{18}$ cm⁻³ n-doped GaAs thin films with a specific contact resistance of ~0.72 Ω·cm².
- NW coverage under contacting pad: 2%.

- Comparison of IV curves of ITO dots and Ni/Ge/Au dots on n-GaAs NWs after annealing.
- Ni/Ge/Au contacts had a specific contact resistance of ~3 Ω·cm² for $5 \times 10^{18}$ cm⁻³ n-doped nanowires.

- 500 nm thick ITO thin films with a transmittance of ~85% and a sheet resistance of ~30 Ω/□ was achieved.
- Te may segregate near the side walls of NWs, which prevents an ohmic contact from forming.
- The contact resistance between ITO and nanowires could be further reduced to minimize the series resistance and maximize nanowire solar cell efficiency.

**References**