Research Center for Photovoltaics

Impacts of V/III ratio on the performance of GaAs p–n solar cells by ultrafast MOVPE

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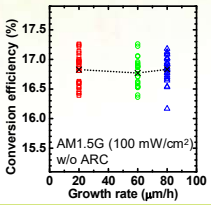
REASERCH BACKGROUND

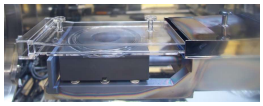
- **From our latest report on high speed grown GaAs[1-2)]**
  - GaAs SCs have *no degradation* when growth rate was increased.
  - Growth rate of **80 µm/h** with **high V/III ratio** of 40



In this study

- **Investigate effects of V/III ratio on quality of GaAs grown at 90 µm/h**
- **Compromised point between material cost (AsH_3) and cell efficiency**

METHOD

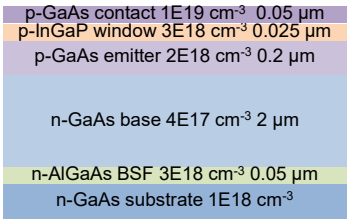


- **Taiyo Nippon Sanso, HR3335**
  - Customized gas flow channel to enhance growth rate

- **Growth conditions:**
  - Total gas flow: 10 SLM
  - Reactor pressure: 6 kPa
  - Reactor temperature: 680ºC
  - Growth rate: 90 µm/h with various V/III ratios
  - n-GaAs substrate 2º off toward <110>

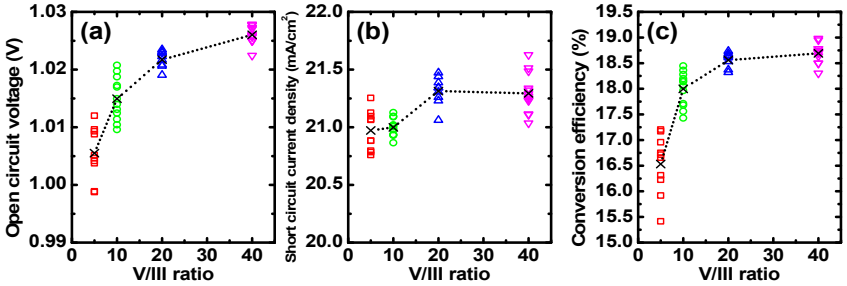
RESULTS AND DISCUSSION

Investigated PV structure



Layer	GR. (µm/h)	V/III	T_g (ºC)
Contact	5	20	600
Window	1.9	100	600
Emitter	20	20	680
Base	**90**	**5/10/20/40**	680
BSF	5	40	680
Buffer	5	20	680

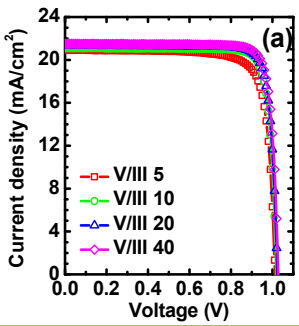
Dependences of V_{oc}, J_{sc} and efficiency on V/III ratio of n-GaAs base



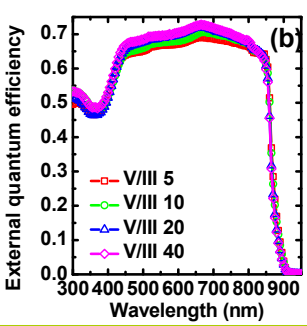
- V_{oc}, J_{sc} and efficiency decreased with a lower V/III ratio.
  - Defects and traps are responsible for these degradations.
- Average efficiency decreased from 18.69 to 18.56, 18.00 and 16.53% with lowering V/III ratio from 40 to 20, 10 and 5, respectively.

- GaAs p-n solar cells with AlGaAs BSF layer
  - Vary V/III ratio of 90 µm/h n-GaAs base layer
  - Doping in n-GaAs compensated with background p-type doping

I-V characteristics



EQE spectra



- Decrease in J_{sc} with lowering of V/III ratio caused by EQE degradation at wavelength corresponding to active range in n-GaAs base layer
- High background carbon[3] and compensation doping might induce defects and traps demoting photo-carrier extraction efficiency.

CONCLUSIONS

- Investigate a compromise between material cost (AsH_3) and solar cell efficiency
- GaAs p-n solar cells with n-GaAs grown with various V/III
  - Degrade in both V_{oc} and J_{sc} by lowering V/III caused by defects in n-GaAs base layer
- With current reactor design and growth conditions
  - For 90 µm/h GaAs, a V/III ratio of 20 is recommended for good GaAs cell efficiency.

REFERENCES

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A part of this study was supported by NEDO project: the research and development of ultra-high efficiency and low-cost III-V compound semiconductor solar cell modules.