Table 9.5 Troubleshooting for n-on-p cells

Problem	Symptom	Confirmation
Window too thick	Poor blue response	Model QE
High front-surface recombination	Poor blue response (lower V_{OC})	Model QE
$L_{emitter}$ < emitter thickness	Poor blue response (lower V_{OC})	Model QE
Emitter doping too high	Poor blue response (low V_{OC}, low emitter sheet res.)	Measure doping of emitter
Emitter doping too low	Low V_{OC}; higher emitter sheet resistance	Depleted emitter
Base doping too low	Low V_{OC}	Measure doping of base
Base doping too high	Low V_{OC}; reduced red response	Dark I-V likely to have $n = 1$
L_{base} < base thickness	Low V_{OC}; reduced red response	Dark I-V likely to have $n = 1$
High back-surface recombination	Low V_{OC} (reduced red response)	Dark I-V likely to have $n = 1$
Threading dislocations	Low V_{OC} (low FF and J_{SC})	High dark current, probably with $n = 2$
Thin metallization	Low FF – series resistance	Measure grid-line resistance
Bad tunnel junction	Low FF – series resistance and/or low V_{OC}	Measure tunnel junction by itself
Extra junction	Low FF – (nonohmic?) series resistance	Shape of I-V may depend on spectrum
Metallization does not make good contact	Low FF – (nonohmic?) series resistance	Use transmission line on front; two pads on back
Resistive window layer	Low FF – series resistance	Use transmission line to measure resistance to emitter
Particulate	Low FF – shunt	Light emitted in forward bias may be correlated with morphological defects
Incomplete mesa isolation	Low FF – shunt, sometimes with unphysically high J_{SC}	Etch mesas deeper or cleave edges
Front metal touches lower layer	Low FF – shunt	Examine under microscope
Severe chromatic aberrations	Low FF for cell measured under concentration	Shape of I-V is unusual [22]

whereas concentrated HCl etches GaInP and AlInP, but not GaAs. GaInP does not always etch in concentrated HCl, especially if the surface is wet, the HCl is not full strength, and/or if the GaInP surface has previously been in contact with a dilute HCl solution.

A window is provided in the Polaron cell for shining light on the aqueous semiconductor junction. The photocurrent (QE) from the junction can fit the form

$$QE = \alpha(h\nu)^* L/[1 + \alpha(h\nu)^* L] \tag{9.25}$$

where $h\nu$ is the photon energy, and it is assumed that L is much longer than the depletion width but less than the layer thickness.