WAFER HEATING WITH IR EMITTERS ON INDUSTRIAL PECVD TOOL

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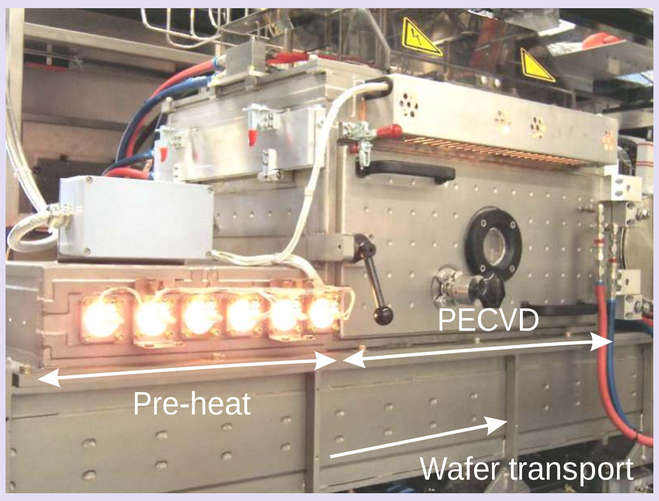
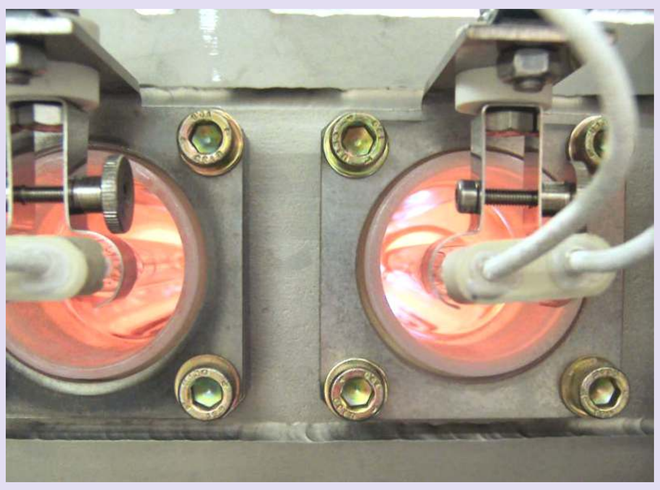
ABSTRACT

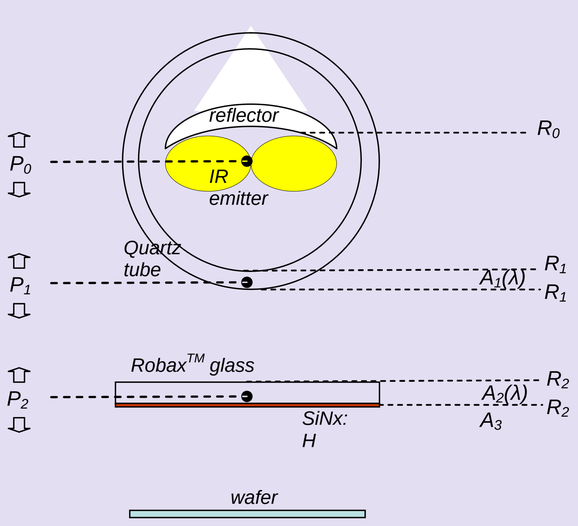
Wafer heating with visible and IR radiation is a well established method used in solar cell manufacturing equipment. However, large heat losses can occur by a non-effective implementation of the heaters and process chamber design, making this heating method very power consuming. This paper gives a quantative description of these losses, providing more insight for an improved equipment design.

A. The DEPx process chamber.

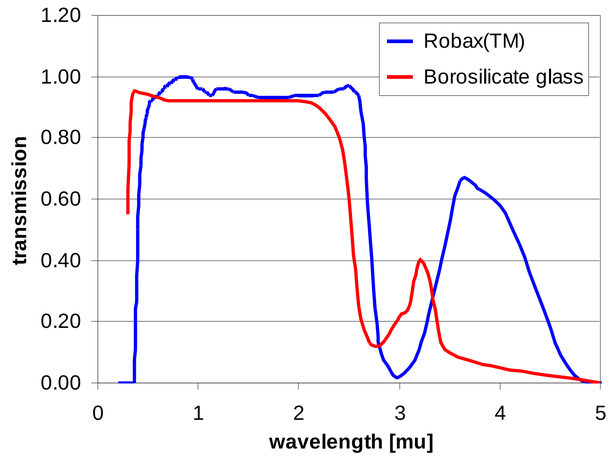


B. Implementation of the emitter.



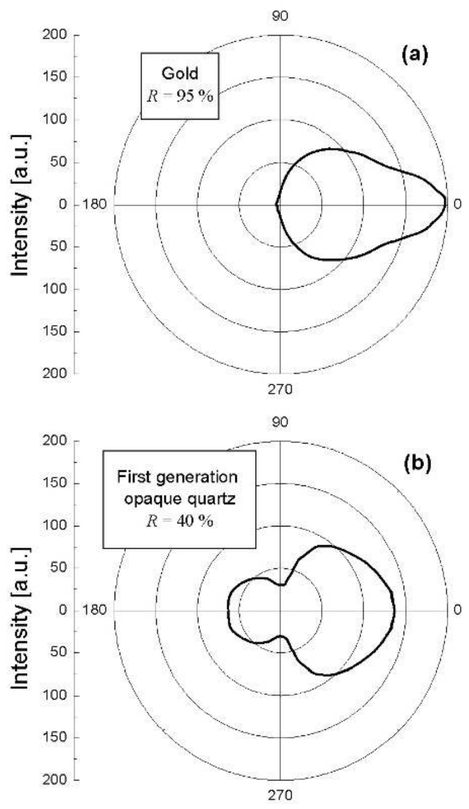


Emitters outside vacuum.
Spectrum altered by absorption in reflector, quartz, robax.
Additional long wave radiation by re-emission.



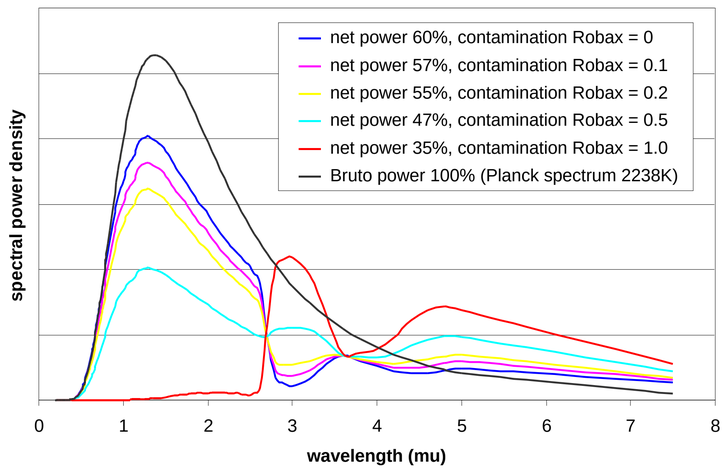
- No quartz tube contamination by use of Robax glass shields.
- Good optical transmission compared to Borosilicate glass.

C. Short wave IR emitters

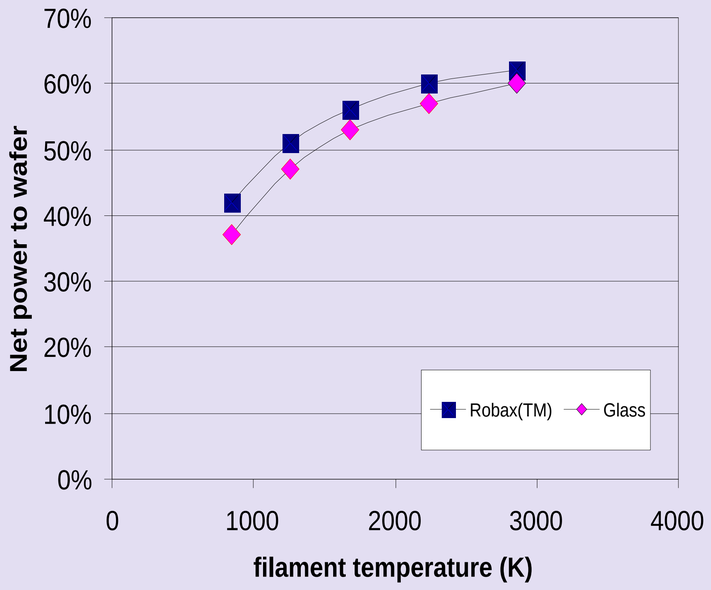


- High power output (up to 4800W)
- High filament temperature (up to 2650K)
- Opaque quartz reflector for durable performance

C. Radiation spectrum



- Net power is 60% for clean system.
- Robax contamination reduces net power down to 35%.



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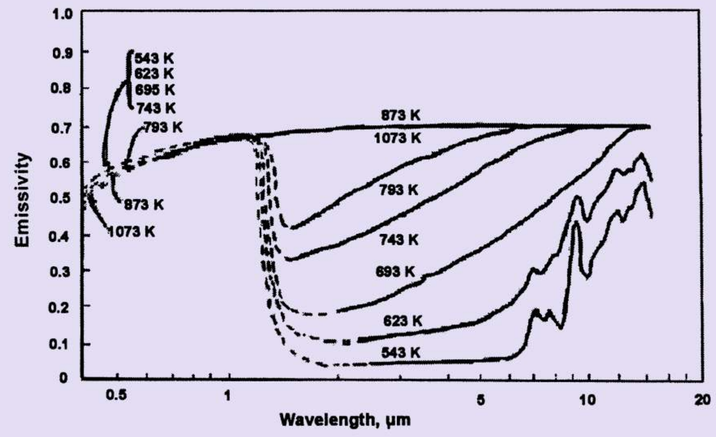
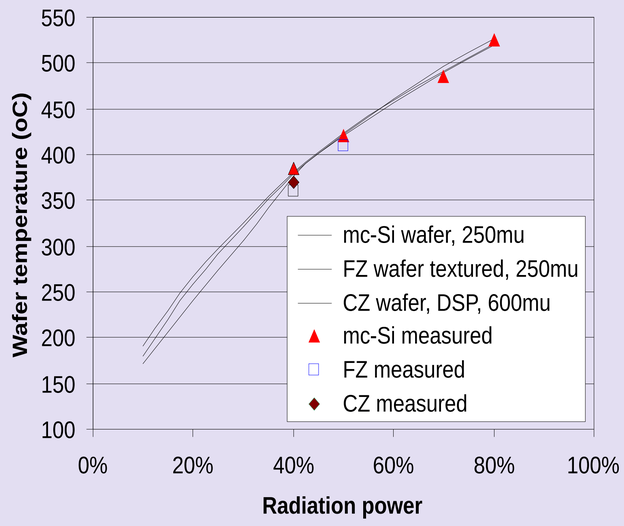


- Emissivity / absorption of silicon solar cell depends on wavelength, temperature, doping level and surface roughness.



- Different wafer types obtain the same temperature due to clever shielding.
- Good agreement with simulations.

CONCLUSIONS:

- Heating system in DEPx: high ease of use (emitter outside vacuum).
- High net power to wafer with use of quartz and Robax.
- High filament temperature -> less heat loss.
- Contamination on Robax -> decrease in net power & shift to IR.
- Absorption / emission of wafers depends on temperature, wavelength, surface and doping level.
- Successful modeling of wafer heating in DEPx PECVD system.