Solar Receivers for Concentrated Solar Power Plant

Joelle BLEIN
CEA Le Ripault, BP 16, 37260 MONTS, FRANCE

(joelle.blein@cea.fr)
Solar receiver for Tower technology

**Topics**

- **Goals:**
  - Development of high temperature receivers (> 1000°C) to increase the generating efficiency of solar power tower

- **Requirements:**
  - Wall temperature: front face > 1300°C, rear face ~ 1000°C
  - Oxidation resistance under pressurised air flow (5 bars)
  - High thermal shocks resistance

- **Candidate materials for air receivers**
  - Ceramic materials
    - Solid substrate for Tube receiver
    - Cellular foam for Volumetric receiver
  - Surface functionalisation
    - Oxidation protective layer
    - Optical selectivity layer
Solar receiver for Tower technology

Development of volumetric air receiver

- Numerical materials:
  - Digitalization of the cellular structure
  - Thermal properties modelling
  - Simulation of thermal behaviour, basic properties pre-dimensioning
- Manufacturing and functionalisation of materials
  - Optimisation of the cellular structure (cells density, size cells, structure characteristics, …)
  - Oxidation protective coating
  - Optical selectivity layer
  - Characterization & Tests behaviour
- Integration of materials in module receiver
  - Definition of a laboratory module representative (geometry, dimensioning)
  - Tests behaviour under representative operating conditions (to be defined)
Previous results on air receiver

- Evaluation of resistance under oxidizing conditions:
  - Thermogravimetric analysis
    - Under air flow from ambient to 1400°C
    - Protective layer is not thermally damaged ($\Delta m = 0.07\%$)
  - Heat treatment furnace
    - Test under air flow at 1000°C
    - No significant mass variation ($< 0.02\%$) after 1000h
  - Thermal shocks
    - Testing facility: air furnace
    - Natural cooled down from 1000°C to room temperature
    - Good behaviour of the protective layer after 15 thermal shocks
Manufacture resources

**Liquid impregnation**

- Hot treatment furnace and carbonizing stove

**Chemical vapor infiltration/deposition**

- Laboratory scale CVI reactor

**Rapid densification (« film boiling process »)**

- « Kalamazoo » equipment

Materials:
- Carbon, carbide or ceramic matrix
- Deposition of carbon, carbide, etc.

**Carbon foam**:
- Density: 0.05 to 1g/cc
- Open porosity: 50% to 97%
- Dimensions: Φ 400mm – H 200mm
- Thermal conductivity: 0.05 to 100W/m*K

**Capacity**:
- Hot zone Φ 150mm – H 300mm
- Coating/matrix materials: PyC, SiC, HfC, ZrC, TaC, etc.