MATERIALS AND STRUCTURES TECHNOLOGY

National Aeronautics and Space Administration

NASA GLENN RESEARCH CENTER

High Heat Flux Laser Laboratory

LABORATORY DESCRIPTION

The High Heat Flux Laser Laboratory has unique testing capabilities to evaluate the durability of material systems under isothermal or thermal gradient conditions using high power lasers with power capacities up to 4 kW. A servohydraulic test rig can superimpose a steady tensile load for creep testing or cyclic tensile load for fatigue testing under representative combined thermal-mechanical loads. Specimen geometries have included coupons, tensile dog-bone type, and airfoil or leading edge subcomponent specimens. Typically, the front side of the specimen is heated with the laser while backside air cooling is provided through a nozzle or showerhead. Both surface temperatures are measured with multiwavelength pyrometers, and an infrared (IR) camera is used to evaluate uniformity of the heated zone. In-plane and through-thickness strains are monitored using water-cooled extensometers.

LABORATORY SPECIFICATIONS AND CAPABILITIES

The Laser Laboratory is a high technology readiness level (TRL) test capability that is both quick turnaround and cost effective.

Laser heating (3,500 to 4,000 W):

- Heat fluxes ~300 to 500 W/cm^2 (260 to 440 Btu/ft^2-sec)
- 1,650 W max. with focused beam (spot size dependent)
- Higher heat flux with mirrored lens

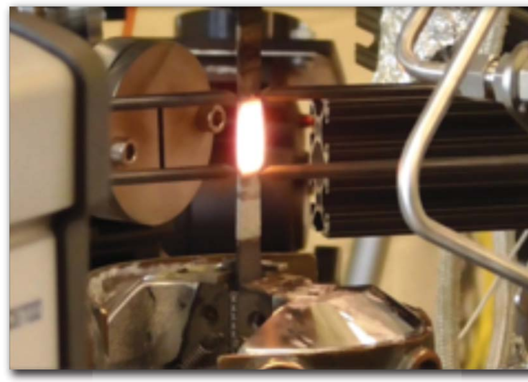
Backside air cooling

Surface temperature:

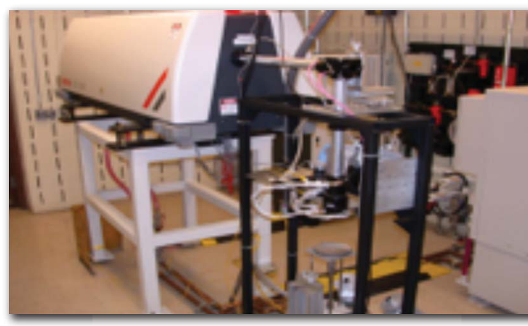
- Multi-λ pyrometers and infrared (IR) camera
- Surface temperatures over 3,100 °F (1,700 °C) are material dependent

Combined thermal-mechanical load

- Multi-axis loading
- In-plane and through-thickness strains



Sustained Peak Low Cycle Fatigue (SPLCF) test in laser simulates combined thermal-mechanical stresses.



3,500 W laser heat source.

SPECIAL CAPABILITIES

The Laser Laboratory has traditionally been used for high-temperature materials development for aeronautics programs and applications including

- Button coupon, dog-bone, leading edge, or airfoil geometries
  - CMC, EBC, SiC, Si_3N_4
- Isothermal, thermal gradient, steady-state (creep), and cyclic (fatigue) capabilities
- Tensile, flexural, fatigue, creep, and thermal conductivity

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Airfoil shape under isothermal laser heating conditions.

Button coupon under thermal gradient conditions can simulate thermal stresses and provide in situ thermal conductivity measurements.