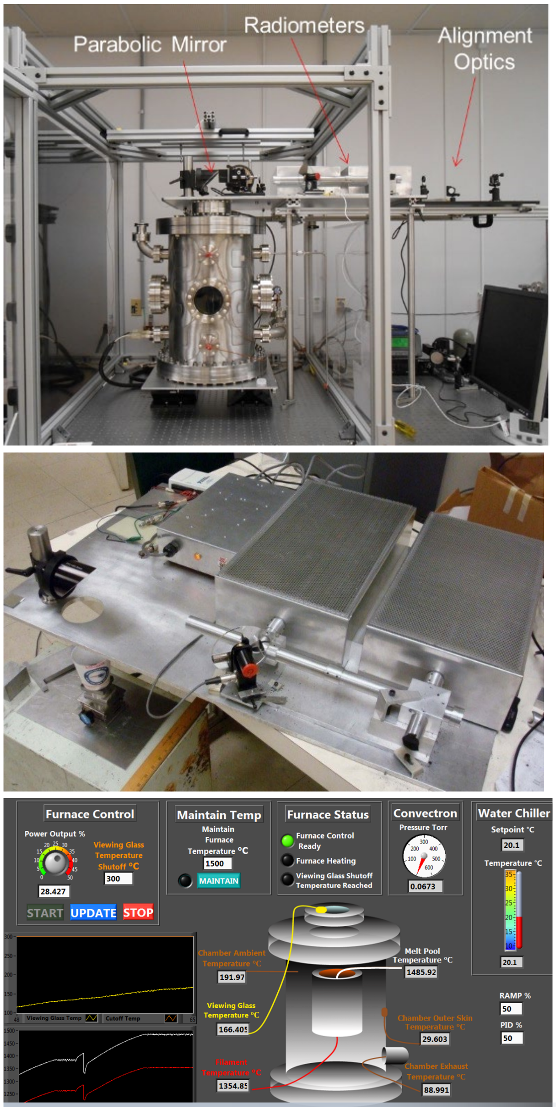
PASSIVE mm-WAVE RADIOMETER SYSTEM

US Patent Pending
Technology Readiness Level: 4
Key Elements Demonstrated in Laboratory Environment

All objects with temperatures above 0 Kelvin emit electromagnetic waves or radiation. In theory, the temperature of an object can be calculated by measuring the intensity of this emitted radiation. However, emissivity variation limits the accuracy of techniques relying on emitted radiation. The emissivity is nearly impossible to predict due to a wide range of factors, such as emissivity temperature variation in different manufacturing environments. The ability to accurately measure emissivity would benefit industries where non-contact temperature measurement is not only useful, but necessary, such as laser metal powder beds where contact temperature measurement is impossible or in high temperature casting operations and foundries where temperature probe immersion can be difficult. To address these wide range of factors, researchers at Sandia, in collaboration with MIT, have developed a non-contact apparatus capable of measuring surface and sub-surface temperatures of objects from ambient to over 5000°C using two microwave receivers simultaneously.

The apparatus is a mm-wave radiometer system capable of measuring thermal emission and object emissivity using a thermal return reflection (TRR) technique and a dual-wave receiver system centered at 137 GHz. Using two receivers allows for seamless measurement of emissivity and temperature without manually changing mirrors and optics. Additionally, the proposed invention does not require a waveguide positioned up to the object of interest. Prior single receiver systems were unable to characterize emissivity and active surface changes, while other systems relied on copper, brass, and mullite waveguides to propagate signal from the object of interest, precluding the ability to perform stand-off temperature measurement or measure very high temperature objects.



Test vacuum chamber furnace with receiver system and parabolic mirror installed (top), dual microwave receiver system (middle), LabVIEW interface and control system for mm-wave radiometer and vacuum furnace test chamber (bottom)

TECHNICAL BENEFITS

- Increased accuracy
- Non-contact temperature measurement
- Does not require a wave guide
- Real time in-situ emissivity measurement

INDUSTRIES & APPLICATIONS

- Aerospace
- Defense
- Advanced manufacturing environments
- Metallurgical processing

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