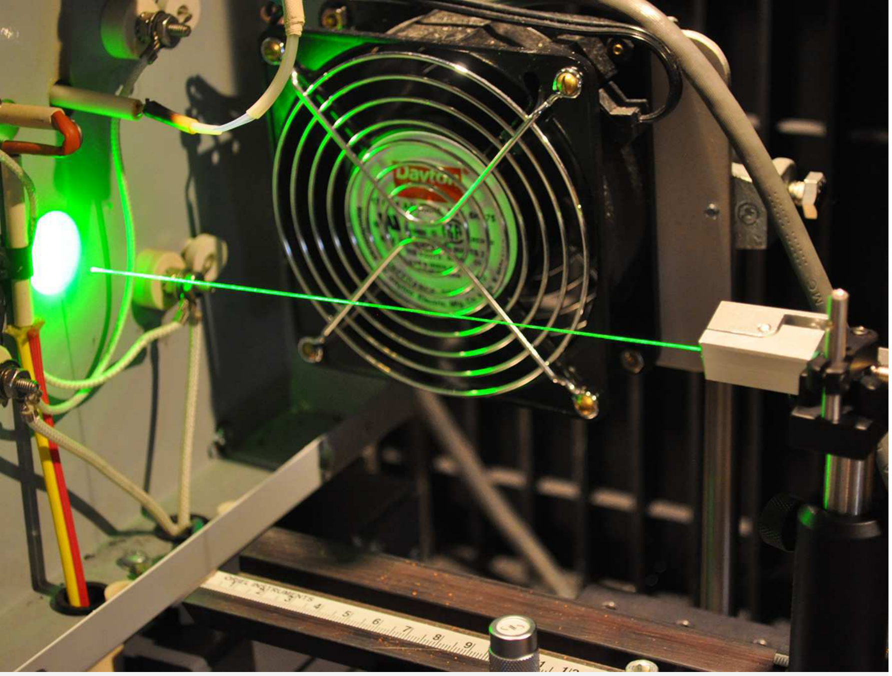

National Aeronautics and Space Administration

technology solution

Sensors

High-Temperature Thermometer Using Cr-Doped $GdAlO_3$ Broadband Luminescence

Accurately measures temperatures capabilities up to 1300°C in real-time

NASA's Glenn Research Center has developed a non-contact, ultra-bright luminescence-based optical thermometer capable of operating in environments with extremely high thermal radiation. This is accomplished through the use of a unique chromium-doped gadolinium aluminate ($Cr:GdAlO_3$) temperature-sensing phosphor. This technology has been proven accurate up to 1300°C - a dramatic increase when compared to current state-of-the-art, which has only been demonstrated up to 600°C. In addition to providing breakthrough temperature measurement capability, this innovation is immune to electromagnetic interference, making it ideal for operation in harsh, high-temperature environments. Furthermore, its unprecedented ultra-bright intensity allows for accurate temperature measurements in the presence of high levels of background radiation where similar technologies fall short.

BENEFITS

- High-temperature capable: Accurately measures temperatures up to 1300°C in real- time
- Accurate: Offers more precise measurements than similar technologies
- Robust: Features a simple design with long-term stability
- Non-reactive: Uses a stable $Cr:GdAlO_3$ sensor that is immune to electromagnetic interference and to chemical/thermal degradation
- Multi-purpose: Can be used for full-field surface temperature mapping, as a temperature probe, or as a pressure sensor

THE TECHNOLOGY

In order to obtain real-time temperature measurements with this technology, the phosphor can either be applied as a coating onto the surface of the object for temperature mapping, or incorporated onto a sensor and attached to the end of a fiber-optic probe for local temperature measurements. Next, the object is exposed to a pulsed light source, which causes the temperature-sensing phosphor to produce an ultra-bright broadband emission. An algorithm is used to evaluate post-pulse emission decay time, which is then converted to a precise temperature reading.

State-of-the-art temperature sensing phosphors suffer from thermal quenching, or unacceptable loss of signal intensity as temperature increases. Alternative high-temperature measurement systems such as thermocouples and pyrometers, offer only spot measurements. Moreover, thermocouples suffer from attachment issues and electromagnetic interference, while pyrometers frequently suffer from reflected radiation interference and unknown surface emissivity. $Cr:GdAlO_3$, which retains ultra-bright emission intensity to temperatures well above 1000°C, provides an ideal solution to all of these issues with a few added benefits. It has a perovskite structure that is both non-reactive and stable in high-temperature environments. Furthermore, it possesses a favorable electron energy level spacing that enables this sensor to maintain stronger signal intensity than its competitors. Due to the broad absorption and emission bands for $Cr:GdAlO_3$ there is considerable flexibility in the choice of excitation and emission wavelength detection bands. The combination of these factors makes this technology a clear choice for luminescence-based optical high-temperature sensing for a variety of industries from aerospace to manufacturing.

This technology offers important applications in a wide range of manufacturing processes in the metallurgical industries

This turbine blade has been coated with Glenn's $CR:GdAl0_3$ temperature-sensing phosphor for temperature mapping

APPLICATIONS

The technology has several potential applications:

- Oil & gas exploration
- Industrial furnaces
- Nuclear reactors and power plants
- Turbine engines
- Generators
- Chemical and material processing
- Rockets
- Missiles and ballistics

PUBLICATIONS

Patent No: 8,695,430

More Information

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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