Improving the performance of high-temperature fossil energy power generation systems, such as turbines, solid-oxide fuel cells, gasifiers and coal-fired boilers, requires careful control of temperatures experienced by key components. In gas turbines, advances in alloys, coatings, and film cooling of turbine blades allows higher firing temperatures and greater efficiencies, or longer component lifetimes. Obtaining the greatest benefit from these advances requires accurate temperature measurement on the component surfaces.

The present work supports the research goal to verify the performance of advanced, CFD-designed aerothermal cooling through experimental measurements. Measurements of surface temperatures and heat transfer under high-temperature flow conditions are desired for the greatest fidelity with turbine operating conditions.

Raman spectroscopy allows accurate, non-contact, high-temperature measurement, without interfering with the heat transfer processes. Unlike an infrared camera, a Raman temperature measurement is not confused by the thermal radiation emitted from hot surroundings which reflects from the test surface.

This work shows that, on high-temperature stable materials such as alpha-alumina (single-crystal sapphire and polycrystalline ceramic, melting point ~2050°C) and yttria-stabilized zirconia (YSZ, melting point ~2708°C), Raman spectroscopy can be utilized for non-contact temperature measurement.

\[ T = \frac{h\nu}{\kappa} \exp(-\frac{\kappa}{RT}) \]

\[ S_{\text{room temp.}} - S_{\text{100°C}} \]

\[ \Delta T = \frac{S_{\text{room temp.}} - S_{\text{100°C}}}{S_{\text{SNR}}} \]

\[ \text{SNR} = \frac{I_{\text{Stokes}}}{I_{\text{anti-Stokes}}} \]

\[ \Delta T = \frac{S_{\text{room temp.}} - S_{\text{100°C}}}{S_{\text{SNR}}} \]

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