Active Millimeter-Wave Pyrometer

P. P. Woskov, D. R. Cohn, D. Y. Rhee, and P. Thomas
Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, MA 02139

C. H. Titus
T&R Associates, Wayne, PA 19087

J. E. Surma
Pacific Northwest Laboratories, Richland, WA 99352

Abstract

A 135 GHz heterodyne receiver with a rotatable graphite waveguide/mirror system has been implemented on a waste remediation DC arc furnace for internal surface temperature measurements. The linear temperature measurement range extends from $<1^\circ$ to approximately 15,000$^\circ$C relative to ambient with a simultaneous capability to monitor surface reflectivity with the local oscillator leakage. Reliable and robust operation on a continuous 24 hour basis in a smoky, dirty furnace environment is demonstrated for a total of 5 furnace runs reaching a maximum temperature of 2200$^\circ$C. Complete temperature profile measurements with approximately 5 cm spatial resolution clearly documented thermal gradients on the slag melt surface and refractory walls and ceiling for all operating regimes of the furnace. The unique active probing capability of this instrument provided additional real time information on melt surface turbulence, changing furnace wall emissivity, and millimeter-wave optic losses inside the furnace.