

Laser Photothermal Radiometric Instrumentation for Fast In-Line Non-Destructive Measurements of Industrial Steel Hardness Inspection and Quality Control

Andreas Mandelis^{C, S}, Xinxin Guo and Konesh Sivagurunathan
*Center for Advanced Diffusion-Wave Technologies, Dept. of Mechanical and Industrial Engineering,
University of Toronto, Toronto, Canada*

Jose Garcia
Photo-Thermal Diagnostics, Toronto, Canada

Salvatore Giunta and Salvatore Milletari
3 Industrial Technologies Department, Avio S.p.A., Torino, Italy

A contact-free, non-destructive laser photothermal radiometric instrumentation technique was developed to meet industrial demand for on-line steel hardness inspection and quality control. A series of industrial steel samples, flat or curvilinear, with different effective hardness case depths ranging between 0.21 mm and 1.78 mm were measured. The results demonstrated that three measurement parameters (metrics) extracted from fast swept-sine photothermal excitation and measurements, namely the phase minimum frequency, f_{min} , the peak or trough frequency width, W , and the area, S , are complementary for evaluating widely different ranges of hardness case depth: f_{min} is most suitable for large case depths, and W and S for small case depths. It was also found that laser beam angular inclination with respect to the surface plane of the sample strongly affects hardness measurement resolution and that the phase frequency maximum is more reliable than the amplitude maximum for laser beam focusing on the sample surface.