Is Time Resolved Infrared Radiometry an Alternative of Positron Annihilation Lifetime Spectroscopy for Defect Detection in Metals: An Experimental Approach and a Model Development

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Time resolved infrared radiometry (TRIR) and positron annihilation lifetime spectroscopy (PALS) are both defect detection methods used in different materials for more than 40 years. Interestingly, both of the methods are similar in many ways, such as non-invasive testing procedures and follow a decay scheme. Both of the methods are successfully applied to metals, polymers, and composites materials. However, the methods are different in application mechanism and principle. TRIR is a thermography technique that measures temperature decay with time of the investigated material whereas PALS uses positronium decay with time of the tested material. In PALS, two-state trapping model is mostly used. Two state trapping model is a positronium trapping model used to describe positron diffusion inside the material. According to the trapping model, high energy positron beam is emitted from radioactive nuclei, diffused into the material, and trapped in a defect caused emissions of comparatively lower energy γ (gamma) rays. We develop a model to describe the similarity between time resolved infrared radiometry and positron annihilation lifetime spectroscopy. In the model, we describe the heat transfer and diffusion mechanism in the investigated material in time resolved infrared radiometry. The model also describes an experimental development for time resolved infrared radiometry research.