Micro- and Nano-particles for the Distributed Sensing of Thermal History

Joseph Talghader
University of Minnesota

Abstract

Fires and explosions are some of the most difficult environments in which to perform sensing. No sensor operating inside such events can include traditional electronic devices because they would quickly be destroyed. In this lecture, a newly reported sensing technology will be reviewed that is designed to measure the temperature versus time relationship of rapid thermal events. It utilizes the dependence of luminescence on the trap populations of dispersed micro- and nano-particles. The thermoluminescence (TL) of various oxide microparticles gives direct information on temperature and time because the trapped charges that ultimately give rise to TL have a probability of detrapping that follows an Arrhenius-type relationship. To test this concept, Mg_2SiO_4:Tb,Co particles with two thermoluminescent peaks have been heated using micromachined heaters over a 232^{o}C to 313^{o}C range on time scales of less than 200ms. The effect of maximum temperature during excitation on the intensity ratio of the two luminescent peaks has been compared with first-order kinetics theory and shown to match within an average error of 4.4%. Other TL particles have recently been tested and shown to survive Pentaerythritol Tetranitrate (PETN) explosions.