NEW MEASUREMENT TECHNIQUES TO DETERMINE MATERIAL PROPERTIES FOR THE CALCULATION OF TEMPERATURE DISTRIBUTIONS

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Equipment which is loaded by the nuclear thermal pulse may temporarily develop large internal stresses or significant changes in those material properties which are relevant for its structural strength. Failure under the load of the following blast wave may then result (synergistic effect). A first step to asses theoretically the survivability of equipment in such an event is the calculation of the temporal and spatial temperature distributions in the loaded material. If the surface temperature or the net heat flux absorbed is known, then the calculation requires the knowledge of mainly two quantities:

- diffusivity, which characterizes the speed of heat wave propagation
- effusivity, which describes the resistance of a boundary to the flux of a heat wave. This is strictly true for materials absorbing ideally at the surface; in the case of semitransparent materials, which absorb the thermal radiation inside the volume, additionally the optical absorption length and the heat capacity of the materials have to be considered.

Unfortunately, the material properties are often not known with the accuracy needed for meaningful calculations. Due to mechanical or thermal treatment the surface values may be different from the bulk parameters given in literature or supplied by the manufacturer. The material properties also may change with temperature over the wide temperature range which has to be considered and may vary locally due to impurities. With photoacustic measurement techniques the required material properties can be determined and the above mentioned problems will be taken into account.
Photoacustic techniques are based on the Generation, propagation and detection of thermal waves. In this paper we present the basic physical theory of thermal waves, the experimental set-up and the principles of thermal wave analysis. The information which can be obtained from the target by nondestructive photoacustic techniques is illustrated by experimental results from different materials.