FIELD MEASUREMENT OF A BLAST WAVE USING AN OPTICAL PRESSURE SENSOR

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ABSTRACT

Pressure-sensitive paint (PSP) is a non-contact, optical pressure measurement technique that can be applied to complex geometries and time-varying flows. The technique gives whole-surface information about pressure and is an excellent source of numerical validation data. An oxygen-sensitive molecule is attached to the surface of interest on a suitable substrate. This molecule, known as a luminophore, when excited appropriately, emits light depending on the local oxygen concentration. This change in emission can be directly related to gas total pressure (assuming a constant mixture ratio of oxygen in the gas) and imaged directly using high-speed cameras. Every pixel in the image captured can be thought of as a pressure transducer. With a suitable camera spatial calibration, pressure on the surface can be integrated to provide loads at both component and panel level. The temporally varying nature of this technique (when applied in this way) allows for unsteady loads to be integrated from the pressure data. The application method of the technique, post-processing methodology, and results generation are described in detail.

Spatial and temporal measurements of the pressure behind a travelling shock wave generated by an explosively driven shock tube are presented. The shock tube was driven using three strands of PETN explosive with the aim of producing a 200kPa overpressure on a round disc placed orthogonal to the exit of the shock tube. Pressure data, including measurements of peak overpressure, wave speed, and wavefront are shown as a spatially and temporally varying video and compared to traditional transducer measurements. Following appropriate application to a surface, the technique is demonstrated to have approximately a 50μs response time (corresponding to a 95% rise following a step change). This paper will show a comparison between two substrates: a simple and very inexpensive thin layer chromatography plate that can be affixed to a surface, and a sprayable ceramic coating that can be applied to any geometry.