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Contact Behavior in an Advanced Pressure and Temperature Sensor for Harsh Environment

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The need to precisely measure temperature and pressure in harsh environment requires more and more sophisticated sensor design. In fact these types of sensors have to be conceived to maintain their performance at temperature up to 1000 ˚C and at pressure up to 1000 psi. In this study is presented a specific structural problem encountered during the design of a pressure sensor that is exposed to a temperature of 1000 ˚C and a pressure of 350 psi; further analysis have been done to evaluate the possibility to extend the use of the sensor to measure pressure up to 1000 psi.

The principle used to measure the pressure is quite simple; the sensor is constituted by a cylinder made of heat resistant material with a thin circular plate at one end and sealed at the other end. When external pressure is applied the circular plate deflects and a particular state of stress and strain develops that allow the measure of the deformation. The material of the plate is such that its coefficient of reflection changes as function of the strain state. Using an optic fiber is possible to measure the amount of light reflected by the plate and consequently its deformation. Moreover the calibration process will establish a correlation between the external pressure and the plate deflection.

One of the problems faced during the structural and thermal analysis of the sensor is that the thin plate became in contact with a circular support placed inside the cylinder. Two major issues are analyzed; first, after the contact, the plate is no longer free to deform as it was simply supported at its boundary and second, the contact can generate a concentrated load on the contact area enough to damage the plate and compromise the measure. The results of the analysis show that the plate deforms in a different way after the contact take place, affecting the sensitivity of the measure and the calibration process. Moreover the state of stress developed is very complex compared to the one of a simply supported plate loaded with a transversal uniform pressure. In particular, compressive stresses and shear stresses are introduced in the plate by the contact with the support. The complete study of the pressure distribution over the contact area as function of the external pressure and temperature is also presented.

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