25 YEARS BASIC RESEARCH IN THE FIELD OF STRAIN GAGE TECHNOLOGY ON CHEMNITZ UNIVERSITY OF TECHNOLOGY - INSTITUTE OF MECHANICS

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0. Introduction

The technique of strain measurement by electrical strain gages is one of the most essential methods in experimental analysis of mechanical loads and in the field of transducer techniques. Investigated where many fundamental strain gage problems in the last 25 years. The paper gives an overview about the most important problems and any research results in this time.

1. Strain transmission and nonlinear resistance strain relations

The precise determination of strain in the high deformation range requires the consideration of the strain transmission and the non-linear strain resistance relation, [1]. It is possible to measure the displacement field of loaded original strain gage installations, using the high sensitive moiré Interferometry, Fig. 1. Furthermore, the nonlinear resistance strain relations are presented, [1].

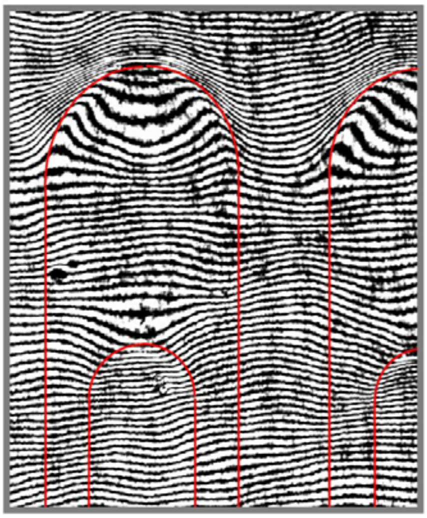

Fig. 1. Fringe pattern, moiré-interferometry, displacement field of strain gage end-loops.

2. Transverse sensitivity, determination and compensation

Strain gages have a small percentage of strain sensitivity in direction transverse to the axis of the gage. A special device to determine this transverse sensitivity was developed, [2]. Furthermore, a special strain gage construction with transverse sensitivity compensation was theoretically calculated, practically implemented and investigated, Fig. 2.

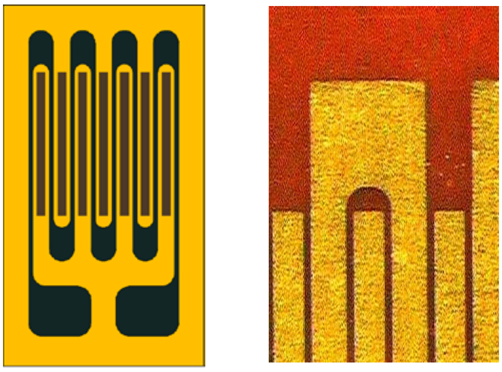

Fig. 2. Gage with transverse sensitivity compensation, schematic layout and industrial design.

3. Calibration of high temperature strain gages

The strain analysis in the range of high temperatures (120–1000 °C) using electrical strain gages is more difficult and it is for various reasons more imprecise in comparison with the measurement at room temperature, [3]. That requires particular kinds of gages, special installation techniques and knowledges in relation to the behavior of the gages during change of temperature. Fig. 3 shows the developed calibration device for the determination of the apparent strain and the gage factor change with temperature.

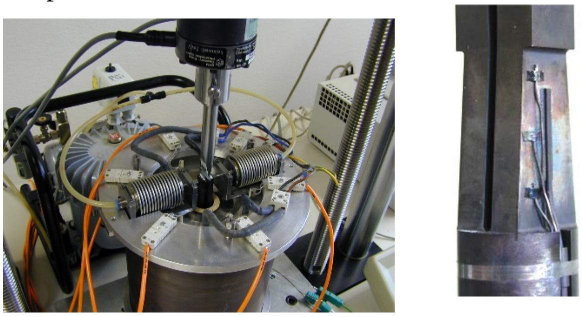

Fig. 3. Calibration device for the experimental determination of the apparent strain and the gage factor change with temperature.

4. Differential strain gage, a new strain sensor for micro application

Differential strain gages consist of a thin square resistance layer with four symmetrically arranged electrical contacts, [4]. Two opposite contacts are connected with a voltage source. The other two contacts must be used to measure the output voltage, Fig. 4.

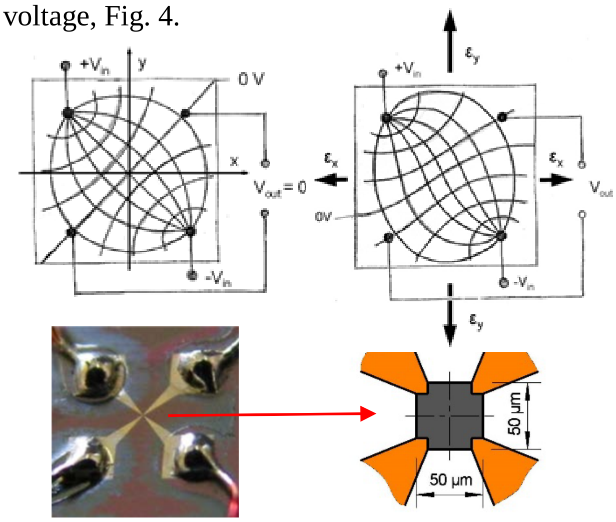

Fig. 4. Differential strain gages, potential lines, subminiature design.

The developed differential strain gage is new and completely differs in function and geometry from the traditional resistance strain gage. The changed basic operating principle and the simple geometric design induce a lot of special properties and some science-based advantages, especially the application in microsystems.

5. Long-term stability in hostile environment

Outdoor applications of strain gages are exposed to environmental influences such as temperature and humidity cycles which lead to irreversible changes in the matrix foils, the adhesives and also in the metallic foils. Therefore it is necessary to protect strain gage installations carefully with special layers against these environmental influences. A test regime with accelerated temperature cycles and test results for gages with different protection coats and different gage constructions is described in the paper, [5]. The climatic chamber with strain gage installations is shown in Fig. 5. This regime consists of continuing temperature changes (10–60 °C) with a period of 6 hours and a superimposed humidity change (30–80 % rel. H.) with a period of 144 hours. The complete testing time lasts 1500 hours.

Fig. 5. Long-term stability test of strain gage installations in a climatic chamber.

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