Electronics – 96032

POLITECNICO DI MILANO





Short Notes on a Few Sensor Technologies

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Disclaimer

Slides are supplementary material and are NOT a replacement for textbooks and/or lecture notes

Purpose of the lesson

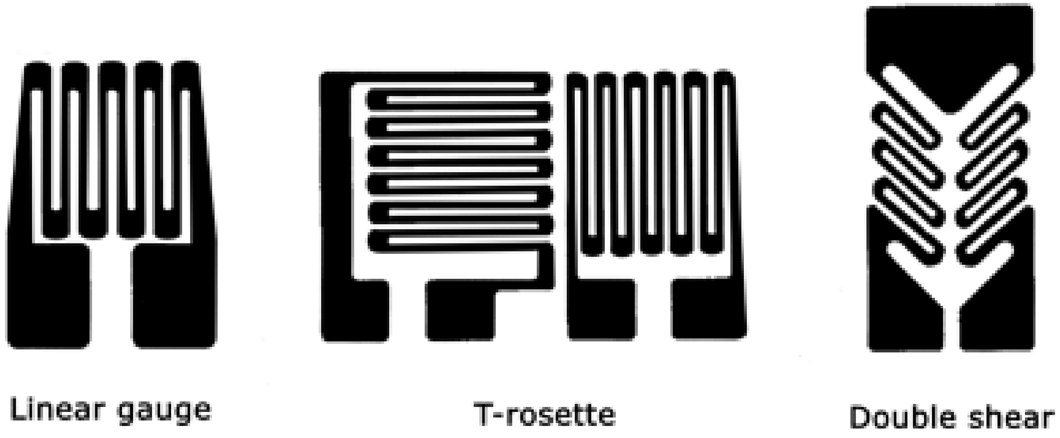
- At this point, we know how to analyze and design simple amplifiers
- Effective amplifier design depend upon the input signal characteristics (impedance, bandwidth,…)
- In this part of the class we discuss a few sensor arrangement:
  - Wheatstone bridge (past lesson)
  - Deformation and temperature sensors (previous lesson)
  - Sensor technologies (optional overview)

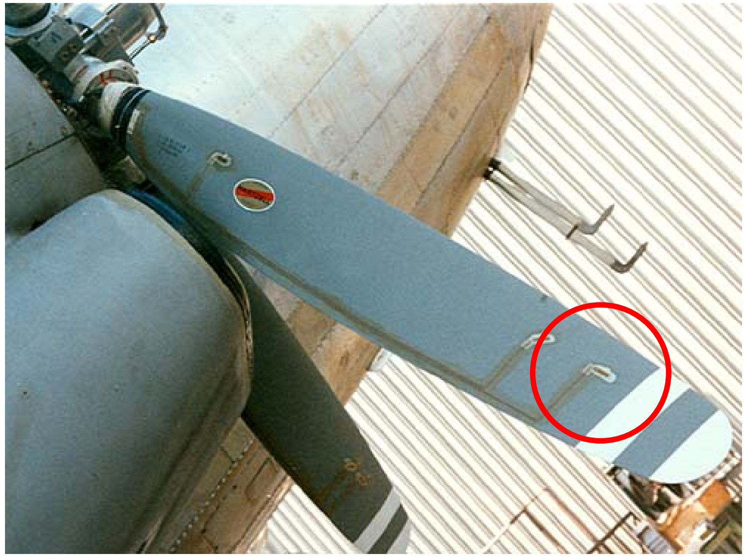
Outline

- Strain gages
- RTDs

Metal-foil SGs

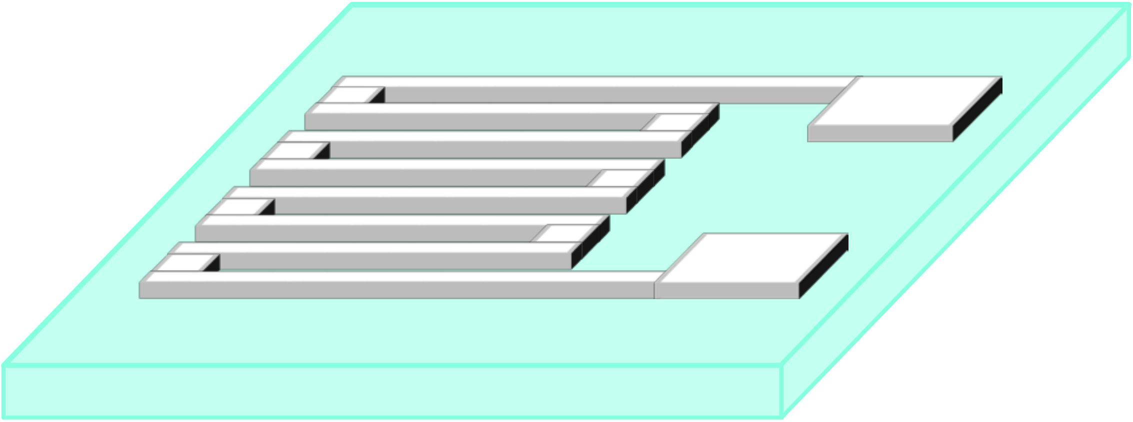
From [4] and [5]



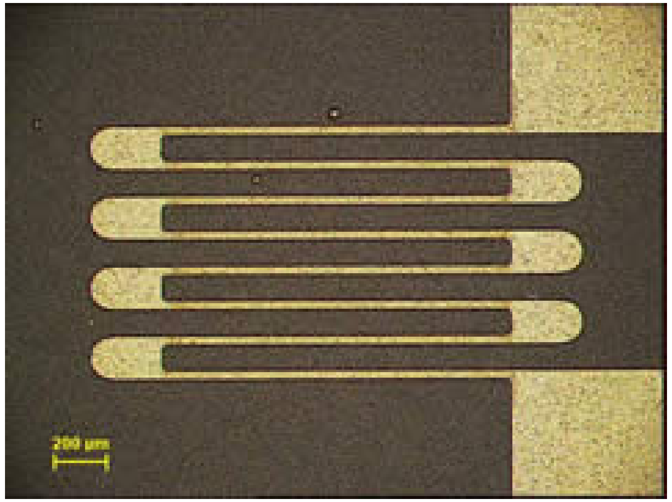


The gage consists of a grid of very fine metallic wire or foil bonded to the strained surface or carrier matrix by a thin layer of epoxy (which must transmit the mechanical strain and be an electrical insulator)

Thin film SGs



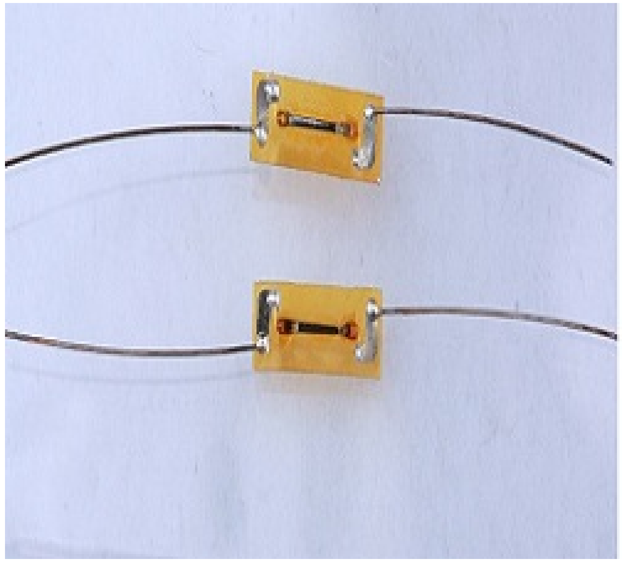
From [6]



An insulation layer (typically a ceramic) is deposited onto the stressed metal surface, and the strain gage is then deposited onto this layer. Vacuum deposition or sputtering techniques are used to bond the materials molecularly

Semiconductor SGs

From [7] and [8]



Larger GF based on piezoresistance, but non-linear and more temperature-dependent. Can be bonded with the same epoxy used for foil gages or directly diffused into the substrate with the technology used for IC manufacturing

Comparison

- Metal foil SGs
  - Very large T range and wide environmental conditions
- Thin film SGs
  - Very stable with very low resistance drift
- Diffused semiconductor SGs
  - Small and inexpensive, strong signal but more T-dependent

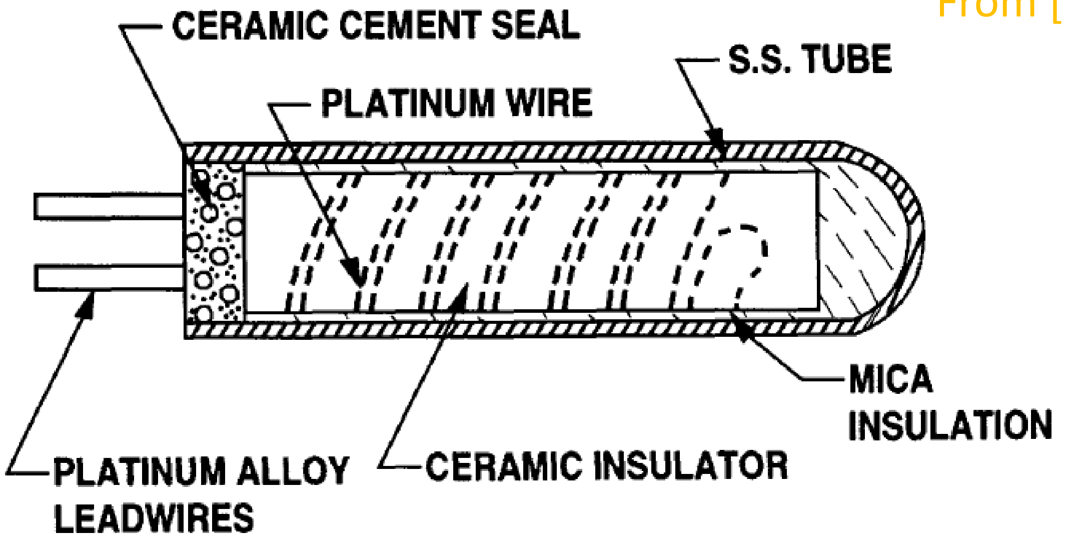
Transverse sensitivity

- SG are also sensitive to strain perpendicular to the longitudinal axis
- In plane wire SG, this is due to the portions in the end loops lying in the transverse directions
- In foil SG many factors contribute (thicknesses and elastic moduli of the backing and foil, width-to-thickness ratio of the foil gridlines,…)
- The transverse sensitivity factor is defined as $K = GF_T/GF_L$ (usually 0 to 10%)

Outline

- Strain gages
- RTDs

Wirewound RTDs

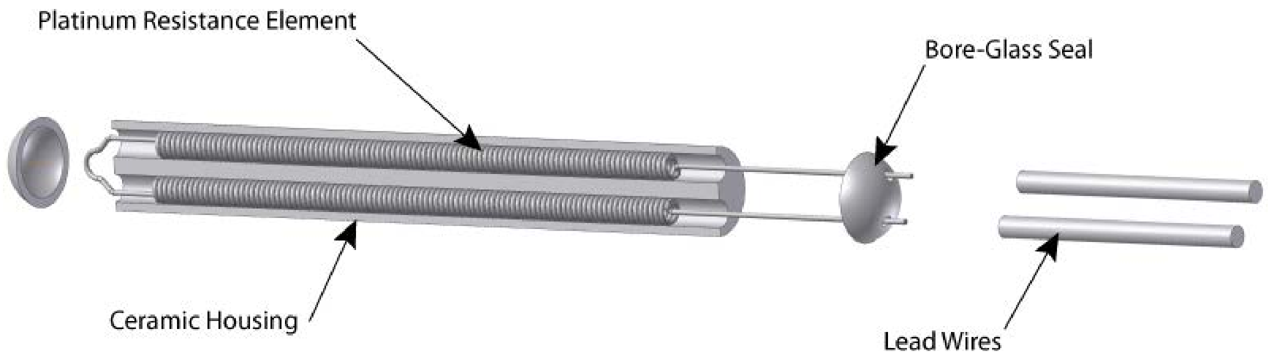


From [2] and [3]

A small Pt sensing wire (usually within 7 to 50 µm diameter) is noninductively wound around a cylindrical ceramic (or glass) mandrel, and covered with a thin layer of material that provides electrical insulation and mechanical protection

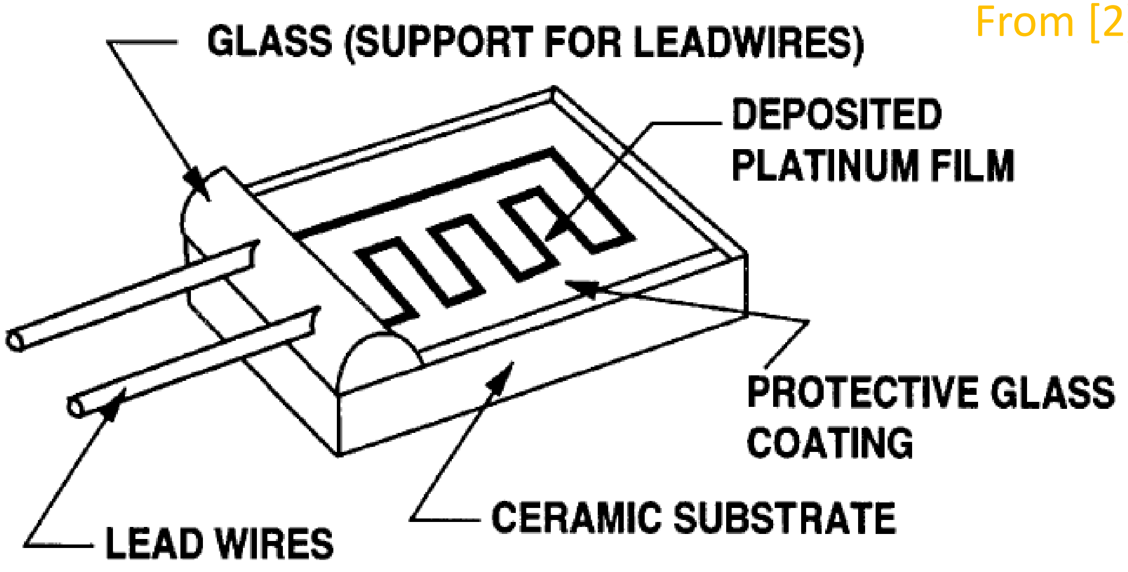
Coil suspension RTDs

From [4] and [5]

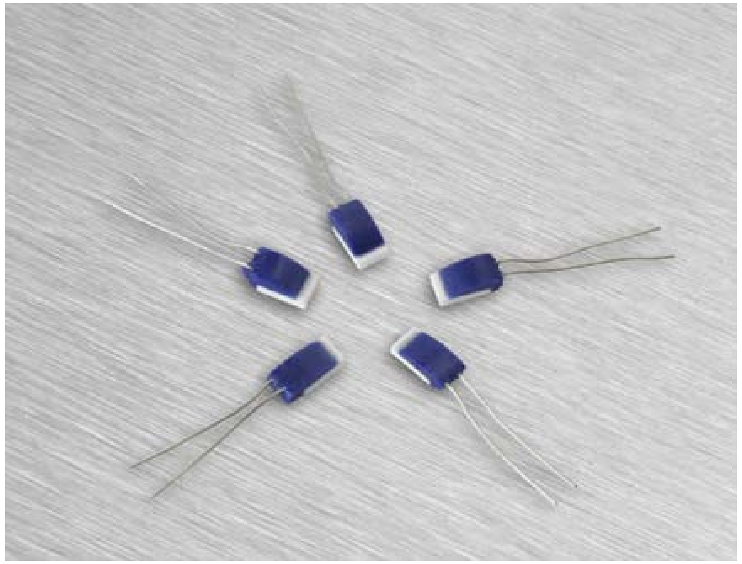


A coil of fine Pt wire is assembled into small holes in a cylindrical ceramic mandrel. The coils are supported by ceramic powder, and sealed at both ends. Ceramic powder allows expansion and contraction, reducing the effects of strain

Thin-film RTDs

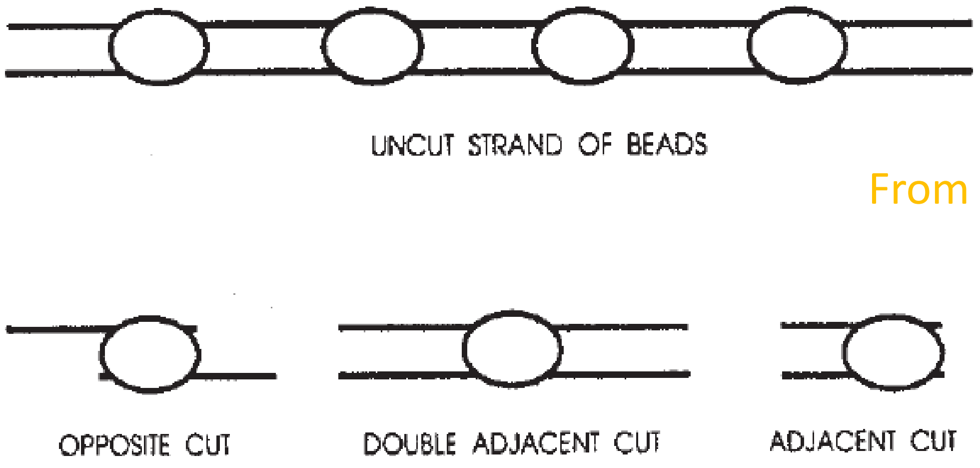


From [2] and [6]

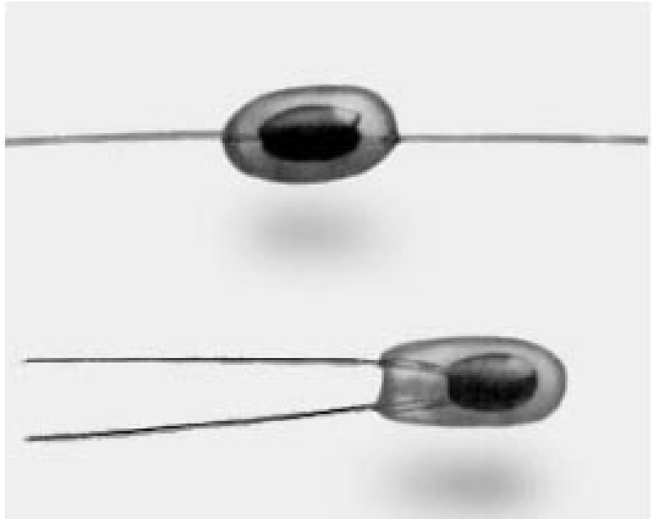


A thin film of Pt is deposited onto a ceramic substrate, then etched, leaving the element pattern. Then, the element's surfaces are covered with glass or epoxy material to protect the elements from humidity and contaminants

Tech: bead thermistors

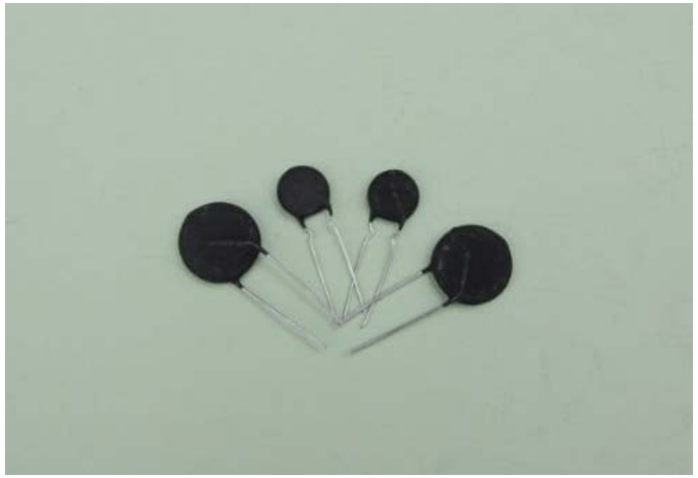


From [8] and [9]

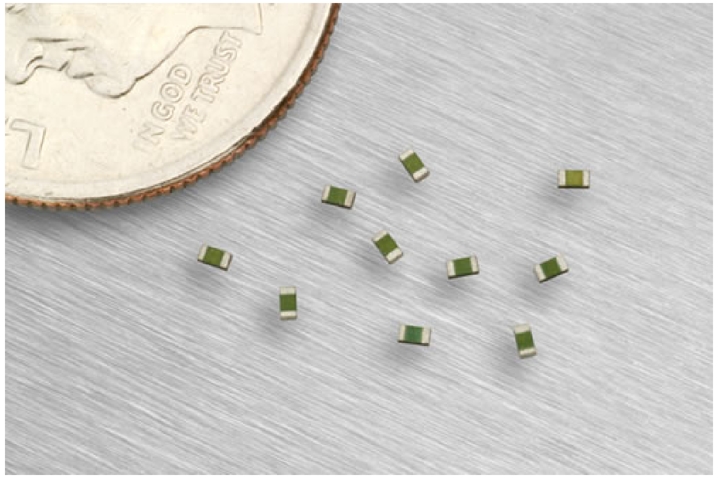


Metal oxide + binder are placed onto parallel Pt leadwires, forming beads. The strand is then sintered, allowing contacts to form intimate bonds with the thermistor. Beads are then cut and coated

Tech: surface contact thermistors



From [10] and [11]



Fabricated by tape-casting (chip) or by compressed metal powders (disk). Metallized contacts are then applied by spraying, painting or sputtering and fired onto the ceramic body.

Also leadless for hybrid- or surface-mount types