DHF Series

Dynamic Heat Flux Sensors

Sensors of the DHF series are intended for very fast thermal phenomena detection and measurement. DHF devices are based on a thin conductive film deposited on the front face of the sensor, coupled with a type K thermocouple. DHF sensor can be used a surface thermocouples, but also as heat flux sensors.

Figure 1 *DHF heat flux sensors in their protective housing. Their thin sensitive film makes them very reactive, but must be carefully handled*

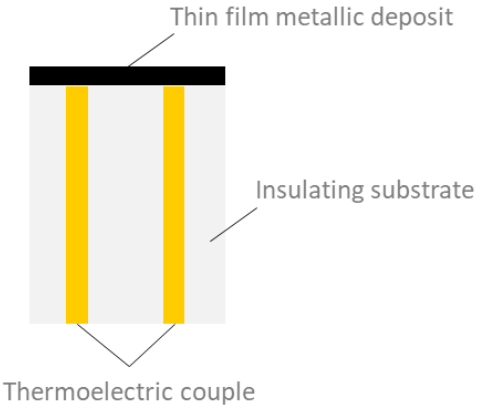


Figure 2 *Illustration of the basic structure of a DHF sensor (scale not representative)*

Introduction

DHF probes are surface thermocouples: a thin electrically conductive film is deposited on a highly insulating substrate:

- The substrate must withstand high surface temperature, while having a very low thermal conductivity. Materials used for the substrate are high performance, machinable ceramics, such as alumina (Al_2O_3), zirconia (ZrO_2) or hafnia (HfO_2) ;
- Thin conductive film is generally made of a high melting point metal or alloy, preferentially having a high emissivity in order to increase incident radiation absorption, such as porous tungsten (W) or porous platinum (Pt) ;
- Thermocouple hot junction is distributed on the thin film by connecting thermoelectric wires to the surface metal (and not directly one on the other). Doing so, the sensor measures the mean (radial) surface temperature.

Compared to a classical wire thermocouple (even of some microns thickness), DHF sensors will demonstrate better reactivity (in terms of signal amplitude and response time) due to a large surface exposed to the incoming heat flux. Another fact contributing to this better reactivity is the presence of an insulating substrate, which generate a fast temperature increase of the exposed surface.

Other benefits compared to classical thin thermocouples are:

- An easier way to handle and to fix on your experiment
- A better robustness of the hot junction towards bad handling
- A perfect fixity in front of a gas flow

Typical use

DHF probes are ideal for fast thermal event characterization, such as:

- Explosion (deflagration), pyrotechnics
- Fire balls
- Engine ignition phase (internal combustion engine, rocket motors, etc.)

and more generally for any application dealing with fast thermal events detection (qualitative) and measurement (quantitative), with typical duration ranging from 1 microsecond to 1 millisecond.

NexTherm Sensing DHF sensors outperform classical competing products by their ability to estimate heat flux, in addition to temperature. This is of a great interest when thermal events must be characterized more precisely.

Standard DHF sensors

DHF sensors are available in two standard versions, according to response time.

Standard model	Thermocouple type	Temperature range	Thin film thickness	Typical rise time (τ63%)
DHF-10	Type K (Cr-Al)	0-1300°C	~10 µm	<1ms
DHF-01	Type K (Cr-Al)	0-1300°C	~1 µm	<1µs

As baseline, DHF sensors are built as follows:

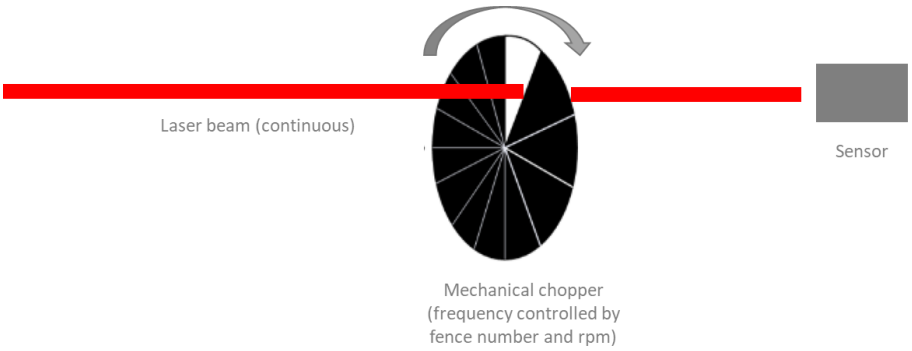
- Type K (chromel-alumel) hot junction, along with a tungsten (W) thin film. To comply with your application, other thermoelectrical couples and surface metals are available on demand ;
- Macor® as insulating substrate. In case of incompatibility with your application (temperature level, chemical aggression, etc.), please contact us for special substrate ;
- Nude probe (*i.e.* no mechanical support). If needed, please contact us for specific thread or flange mounting ;
- Standard wire with length is 1 meter. Miniature type K connector with flat plug completes the baseline version.

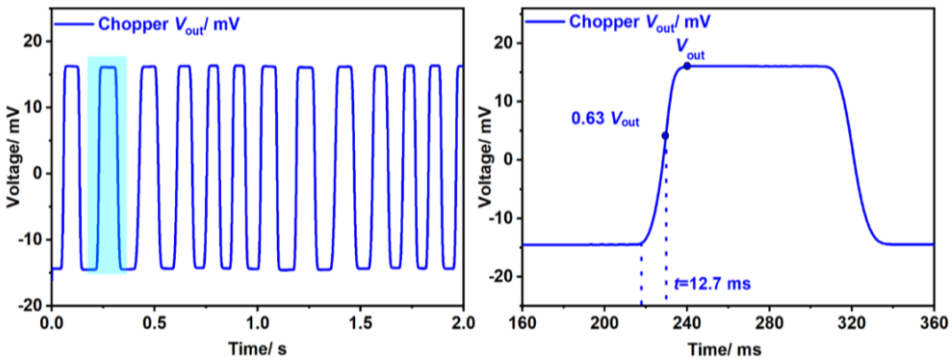
Calibration

Sensor temperature accuracy is determined in a thermostatic bath, with a reference temperature sensor (PT-100 probe). Note that real temperature accuracy in your application depends on your overall hardware configuration (wiring, signal conditioning, DAQ performance).

Heat flux calibration is then carried out on our dedicated laser test bench. It is based on a continuous, high stability, CO_2 laser source (400W), generating a beam with an adjustable diameter (typically 10mm). Laser beam is shaped by a specific optical arrangement to obtain a spatially uniform heat flux density. Power control is monitored though two calibrated power-meters (one in-line and one on a 0.5% power pick-up).

Response time (63%) of each unit is established by the means of a chopper wheel placed in front of the laser beam:





ORDERING

For standard model ordering, please use the following referencing:

DHF-FT-MF-TC-MS

with the corresponding coding:

- FT : film thickness (10 for 10 microns film, 01 for 1 micron film)
- MF : material of the film (baseline : tungsten (W))
- TC : thermocouple type (baseline : type K (K))
- MS : material of the substrate (baseline Macor®)

Example: for a DHF sensor with a 10 microns thin film, using tungsten finish, type-K thermocouple and Macor® substrate: DHF-10-W-K-MACOR

For other configurations, please contact us.

Sales contact

NexTherm Sensing
6, Impasse Louis Bentajou (headquarters)
31410 Longages, France

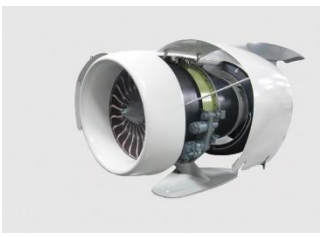
contact@nextherm-sensing.com

+33 (0)6.45.13.04.71

www.nextherm-sensing.com

Aerospace/Defense

Nuclear/Power plant



Turbomachines

Furnaces/Foundry

Fire safety

Braking systems