Ultrafast response Ultra-fine & Ultra-thin thermocouples

1. Introduction
Traditionally, thermocouples have been widely used for temperature measurements for low cost and easy to use. This conventional thermocouples had usually ball-shaped tip of about φ0.5 mm. We have developed thermocouples with faster response as below.

2. Development of ultra-fine and ultra-thin thermocouples with ultra-fast response
① Smaller heat capacity is better for sensitive tip.
② Larger heat transfer area is better for sensitive tip.
③ Tip of thermocouple should be a fine wire of few millimeters length to prevent heat transfer.
(Heat tends to escape through the thermocouple wire itself)
④ For better handling, at least 100µm diameter thermocouple wire is needed except the tip.
Ultra-fine thermocouple fits above ①③④ conditions with fastest response.
Ultra-thin thermocouple fits above ①②④ conditions with some toughness, and suitable for measuring the temperature of object’s surface.

3. Specifications and applications of the ultra-fast response thermocouples
Our ultra-fine thermocouple (mainly K-type) has its tip made of 13µm, 25µm, or 50µm chromel-alumel wire for tip only.
Our ultra-thin thermocouple has its tip thickness between about 10 and 80 µm and mainly suitable for measuring object’s surface temperature. These ultra-fine and ultra-thin thermocouples are possible to measure temperature regardless of the solids, liquids, gases at unprecedented ultra-fast response. For example,
Temperature of the gas in the automobile engine cylinder rotating with several 1000rpm
Temperature of air bags inflater gas in an instant when a car crash
Temperature change of a single living cell in a short time of 20msec called patch clamp
Temperature of IC junction to prevent destruction
Temperature of IC flip chip underfill
Temperature changes during the explosion of gunpowder
Temperature of tip end of bite or end-mill in a short time

Moreover, recently we have succeeded in measuring the temperature of explosion of gunpowder of high speed change (μsec order, about 1/1000 time of the above example) using 25µm ultra-fine thermocouple. We would like to announce in the future.

4. Example of measured temperature data
Following shows the gas temperature in the cylinder of a micro Sterling engine driven by candle as an example of fast response.
Sampling time : 1msec
Thermocouple type: 25µm ultra-fine thermocouple (installed in φ2mm SUS tube)
One division in the axis of abscissas: 50msec
Rotating speed about 1090 rpm (1cycles=55msec)
Temperature range: 185 ~ 220 °C

5 Sales
Last year we shipped more than 12,500 thermocouples mainly in Japanese market. Basically all our thermocouple is made to order.
We are planning to sell our thermocouple world-wide.