

**FUNDAMENTALS OF RADIATION THERMOMETERS: Tetsuro Kobari Director of Sensor Division  
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**What are radiation thermometers?—Classification of thermometers:**

Heat conduction is generated by contact of <a material to be measured> and <a material as a temperature sensor>. <Temperature measurement utilising heat conduction> is a technique to figure out temperature utilising change of characteristics which <a material as a temperature sensor> shows when the temperature of <a material as a temperature sensor> becomes the same as the temperature of <a material to be measured>

In this method, for any characteristic of any object, if it has a law-relation with temperature, it can be used as a temperature sensor. By the diverseness of this law, various types of temperature sensors (for example, thermocouples using the “Seebeck effect”, resistance thermometers using the resistance temperature coefficient of platinum or Germanium, glass thermometers using the coefficient of linear expansion of mercury, alcohol, etc. have been realised.

On the other hand, heat transfer (thermal radiation) is performed also in the form of an electromagnetic wave from <a material to be measured> to <a material as a temperature sensor> and temperatures can be calculated by obtaining change of the electromagnetic wave. This is <temperature measurement using thermal radiation>.

In this method, as the law nature of thermal radiation is directly utilised for measurement, one type of sensor in nature is always available

**Why is a radiation thermometer used?—Usefulness of a radiation thermometers**

The primacy of <thermometers utilising thermal radiation> over <thermometers utilising heat conduction> has come from using thermal radiation. Two primacy points are that <non-contact temperature measurement> is enabled by transmission of thermal radiation in space and <high speed temperature measurement> is enabled by transmission of thermal radiation at the speed of light.

For the advantage of the <non-contact temperature measurement>, it is divided roughly into the <remote measurement> and the <measurement not generated by heat storm>.

In the <remote measurement>, there are the <long distance measurements> for weather surveys such as measurement of cloud temperature from the ground, measurement of sea temperature

from the air, the <isolated measurement> for measurement of sample temperature in a vacuum furnace through a window, the <moving object measurement> for measurement of temperature of continuous heat-treatment steel materials such as hot-rolling in the steel industry and the <high temperature object measurement> for measurement of about 1500°C or higher which melts the sensor part of <thermometers using heat conduction>

The <measurement generating heat storm> means that, for the <thermometer utilising heat conduction>, the temperature of the measuring object may be changed by heat transmission from a high temperature measuring object to a low temperature sensing part by the contact of the measuring object and sensing part and accurate measurement becomes impossible. The <measurement not generating heat storm> is enabled with radiation thermometers which are effective in <temperature measurement> such as metals etc.

In the <high-speed temperature measurement> for the <thermometers utilising heat conduction>, a temperature sensor needs to contact a measuring object and a certain time is necessary until the measuring object and the temperature sensor reach the same temperature (in order to realise sufficient thermal contact, not simply mechanical contact).

On the other hand, radiation thermometers do not need such time and can measure temperature at a high speed. For example, although it is necessary to wait for at least 3 minutes to measure accurate temperature by mercury type thermometers, the usual response time of radiation thermometers is 1 second or less and a response time of 0.001 second or less is available.