Development of measuring instrument for thermal diffusivity of thin films

Instrument for easy and fast measurement of thermophysical properties of thin films

A measuring instrument for thermal diffusivity of thin films with thickness of around 1 μm has been developed based on a pulsed light heating thermoreflectance technique. The instrument observes transient temperature change at the surface of the film with 1 ns time resolution. One face of the substrate side of the thin film is heated by pulsed laser with the duration of 2 ns, and the temperature rise at the opposite face is detected by sensing reflectivity change of the film. For the observation of the reflectivity change of the film, a continuous wave laser diode is used instead of a pulsed laser for the conventional thermoreflectance measurements. We measured the thermal diffusivity of a titanium nitride film (680 nm) using the developed instrument, which coincided with the data obtained by the standard instrument of NMIJ, AIST. The developed instrument has several features: desktop size and short data acquisition time about 1 minute.

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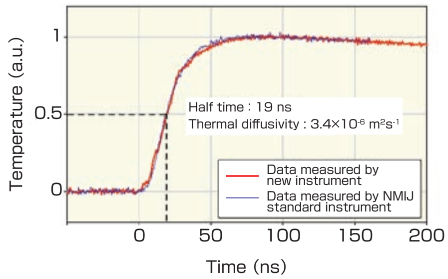
Thermal diffusivity measurement for titanium nitride film (thickness: 680 nm)



Transient temperature change for the titanium nitride thin film (thickness: 680 nm) obtained by the developed instrument along with that measured by the NMIJ standard instrument

To realize the world top class temperature standard

The development of highly pure fixed point apparatus and its evaluation

The evaluation of impurity effect on the realization of fixed-point temperatures of the International Temperature Scale of 1990, by which the temperature standard is defined, is essential, since impurity in many cases lowers the fixed-point temperature.

First, the impurity effect was evaluated by a theoretical approach using the impurity information obtained from a chemical analysis of the fixed-point substance. A direct comparison of fixed-point temperatures realized by two different substances was conducted as the second approach. The applicability of these two methods, however, is limited so that the impurity effect cannot be evaluated properly. To this concern, analysis on the changes of temperature and liquid fraction during the realization of the fixed point was performed as the third method. It has been found here that this third method provides a lot of accurate information for estimating the defined temperature, including those provided by the other two methods. Based on the third method, a world top class temperature standard has been realized.

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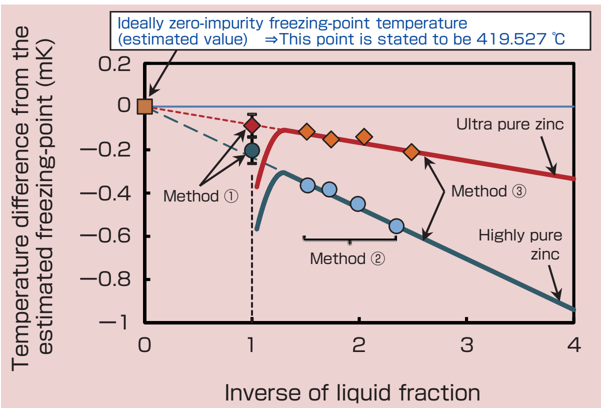

Estimation of zinc freezing point based on three methods