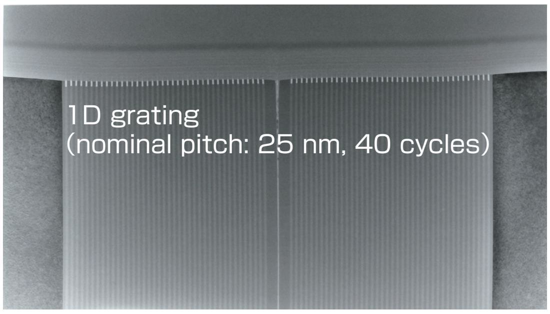
Expansion of pitch calibration range of one dimensional grating standard

The minimum pitch extended to 23 nm

One-dimensional (1D) gratings are one of the most important transfer standards for nanometrological instruments. National Metrology Institute of Japan (NMIJ) of AIST developed metrological atomic force microscopes (AFMs) and has supplied pitch calibration services (minimum pitch: 50 nm). Furthermore, a pitch calibration system based on the JCSS (Japan Calibration Service System) was also constructed with Japan Quality Assurance organization (JQA). JQA supplies pitch calibration services (minimum pitch: 97 nm) and the number of calibrations are a few hundred per year. Industry, however, requires calibration services for increasingly smaller pitches. This time, NMIJ has developed 1D gratings consisting of multilayer thin films and calibrated them. Furthermore, NMIJ conducted comparison measurements with the national metrology institute of Germany (PTB) using their own metrological AFMs. Based on the comparison results, NMIJ has expanded the minimum pitch calibration range to 23 nm. In the near future, the pitch calibration range of the JQA will be also expanded.



Transmission electron microscope image of the 1D grating (nominal pitch: 25 nm, cycles: 40) consisting of Si/SiO_2 multilayer structures
The 1D grating has two scale areas, area 1 and area 2.

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Metrology and Measurement Science

Thermophysical property measurement for gases using an acoustic technique

Development of the apparatuses for acoustic resonance measurement with a spherical and a cylindrical cavity

Sound waves can be used for measurement of thermophysical properties for fluids. The author developed apparatuses for acoustic resonance measurement with a spherical and a cylindrical cavity to measure thermophysical properties of gas samples. In the spherical cavity, acoustic resonance frequencies can be accurately measured so that speed-of-sound of gas samples can be also accurately determined. Speed-of-sound is one of the thermodynamic properties related to density and compressibility, and is useful information to develop the thermodynamic equations of state for fluids. Recently, the author measured speed-of-sound for refrigerants with very low global warming potential, contributing to the development of the equations of state for them which are required to evaluate the cycle performance of the air-conditioning system. On the other hand, the half-width of acoustic resonances can be accurately measured using the cylindrical cavity, leading to obtain viscosity and thermal conductivity of gas samples. In the future, the author plans to accurately measure speed-of-sound of mono-atomic gas samples to derive the thermodynamic temperature, and reevaluate the international temperature scale (ITS-90).

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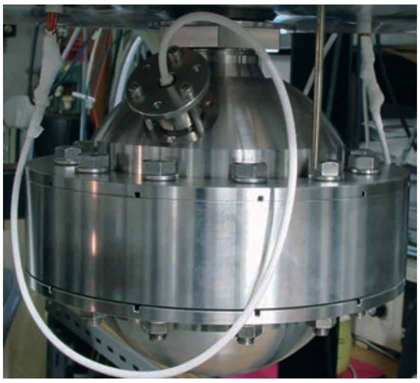

The apparatus for acoustic resonance measurement with a spherical cavity, which enables accurate speed-of-sound measurement for gas samples