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Body of abstract in 12 pt Times. Single space. Aligned both sides (double justification). No line spacing between paragraphs. (Microsoft Word automatically adds a little space for aesthetics – auto line spacing.) Indent paragraphs using four spaces.

References and notes should be denoted by numbers in square brackets[4-6] and listed below the body text. The whole document should have a paper size of ‘A4’ which will be reduced for printing in the book of abstracts. Paper margins are 2.5 cm top, bottom left and right. Place figures and tables in the body text centered on page.

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**Measurement of absolute thickness of ultra-thin oxide films by mutual calibration method**

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Thickness measurement of HfO2 films has been studied by a CCQM pilot study of Surface Analysis Working Group (SAWG). The thicknesses of the HfO2 films were measured by XPS, XRR, TEM, Ellipsometry, X-ray Fluorescence (XRF), Rutherford Backscattering Spectrometry (RBS) and Medium Energy Ion Scattering Spectrometry (MEIS) from 11 national metrology institutes (NMIs) and 2 individual laboratories.

The thicknesses of the HfO2 films grown by atomic layer deposition were measured by a MEIS system of KRISS with a time of flight (TOF) analyser. The film thicknesses were determined from the MEIS intensity ratios of the film material and substrate Si (*I*Hf/*I*Si) as shown in Figure 1(a) by mutual calibration of the MEIS intensity ratios and the thicknesses by XRR or TEM.[1]

In P-190, the reference thicknesses of the HfO2 films grown by atomic layer deposition were determined by mutual calibration between the thickness by MEIS and the average thickness by XRR reported in the pilot study P-190. The reported results were linearly fitted to the reference thicknesses as shown in Figure 1(b).[2]

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| --- | --- |
| (a) | (b) |
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| Figure 1. (a) Thickness measurement by MEIS and (b) linear fitting results of P-190 to the reference thicknesses determined from MEIS and XRR. | |

[1] K. J. Kim, T. G. Kim, J-H. Kwon, H. Ruh, K. Park and W. J. Min, *Metrologia* 57 (2020) 025001

[2] K. J. Kim, et al., *Metrologia* 58 (2021) 08016