Novel techniques for electrical impedance metrology

Summary

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This dissertation reports the work I performed at the Istituto Nazionale di Ricerca Metrologica (INRIM), Turin, Italy, and at the Korea Research Institute of Standards and Science (KRISS), Daejeon, Korea as a guest researcher. The dissertation briefly introduces the definition of impedance standards and the units in the International System of Units (SI) and presents a number of developments in calibration techniques for instruments and devices employed in primary impedance metrology. Most of the research activities are related to the realization of the resistance and capacitance units in the revised SI.

My PhD activities were mainly performed at the Laboratory of Impedance Metrology of the Quantum Metrology and Nano Technologies Division of INRIM, focusing on the development of calibration methods for LCR meters, the *build-up* method. This method requires only a small number of uncalibrated base capacitors, to be connected in parallel in various combinations, and a single calibrated capacitor, which provides the measurement traceability. The outcome of the method is both the determination of the meter error and the calibration of all the base capacitors, and it can therefore be considered also a capacitance scaling method.

The research period at KRISS was conducted from August, 2019, to September, 2020, in which I worked on the development of the new traceability chain for a capacitance standard from a quantized Hall resistance standard, and on the precision measurements of graphene quantum Hall effect device.

The initial work focused on the capacitance unit, with the calibration of a 10 nF capacitance standard from the quantized Hall standard using a fully digital bridge.

The second work at KRISS is about the DC characterization of a graphene quantized Hall resistance standard, which is a new, promising material for the applications of quantized Hall resistance standard in impedance metrology. The experiments include the test of the long-term stability of the device through a trilateral trip, a DC comparision between GaAs device and graphene device, and the characterization of a graphene Hall resistance array. These activities are part of the EMPIR 18SIB07 GIQS project, Graphene Impedance Quantum Standard.