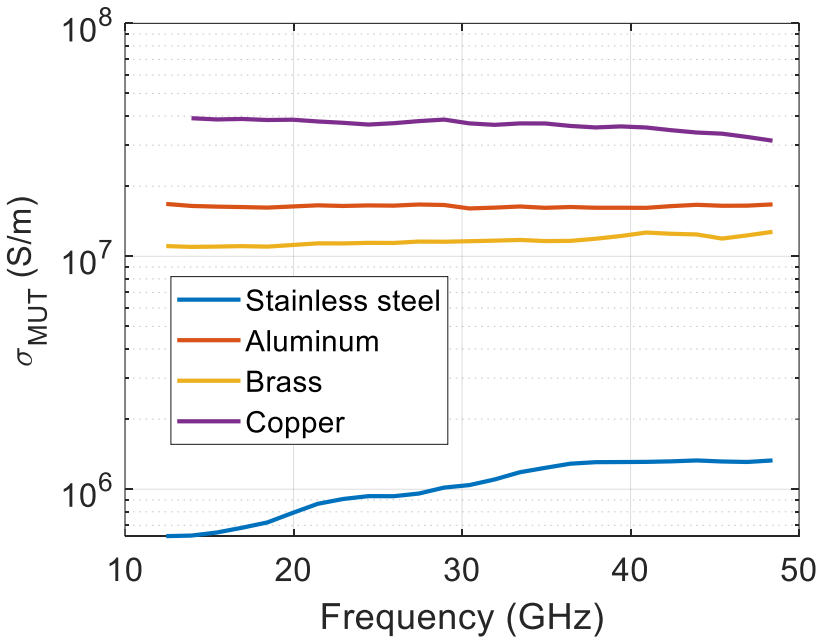
FABRY-PEROT OPEN RESONATOR 20-50 GHz CONDUCTIVITY MEASUREMENTS

EMArges offers a novel type of a **Fabry-Perot open resonator** (FPOR-C) operating in the concave-planar configuration dedicated for automated broadband and accurate resonant measurements of electromagnetic properties of **conductive materials** in the **20-50 GHz** frequency range.

- The FPOR-C system is equipped with specialized PC **software** controlling the measurement process and extracting the conductivity of the material under test based on measured data (the frequency and quality factor).
- The measurement setup consists of a PC connected to the FPOR-C and to a measurement equipment (either a VNA or a **scalar Q-Meter**).
- The FPOR-C operates at consecutive $TEM_{0,0,q}$ Gaussian even modes spaced every **1.5 GHz**.
- The total measurement time for the 20-50 GHz range usually does not exceed **10 minutes thanks to robust algorithms for tracking of resonant modes**.

Fabry-Perot Open Resonator for Conductivity measurements



Exemplary measurement results

The system allows measuring samples of material-under-test (MUT) with following properties:

- **conductivity (σ_{MUT}): $5x10^4$ – $4x10^7$ S/m ($2x10^{-6}$ – $2x10^{-3}$ Ωcm).**
- **thickness**: a sample must be at least several (5 or more) skin depths thick at each measurement frequency, e.g. the thickness of the sample with $\sigma = 5x10^4$ S/m (or $2x10^{-3}$ Ωcm) must be at least 80 μm to perform a measurement in the full band of 20-50 GHz.
- **diameter**: 75-150 mm
- effective conductivity is measured, which accounts for **surface roughness**.

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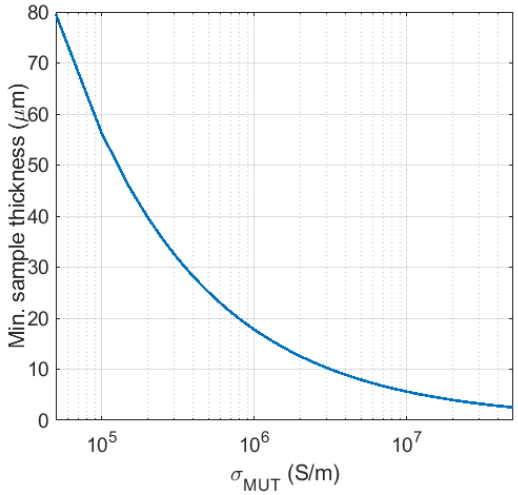
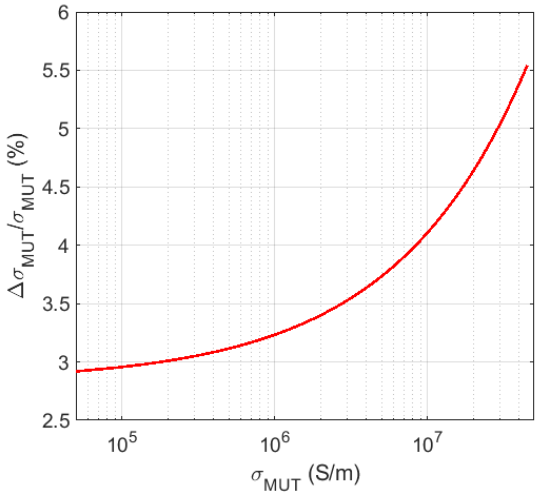
Parameters of a Fabry-Perot Open Resonator for Conductivity measurements (FPOR-C)

Accuracy/uncertainty	$\frac{\Delta\sigma_{MUT}}{\sigma_{MUT}} = \frac{4\sqrt{\left(\frac{\Delta Q_0}{Q_0}\right)^2 + \left(\frac{\Delta Q_t}{Q_t}\right)^2}}{2 - \frac{Q_t}{Q_0}}$ Q_0 (Q_t) – Q-factor of the resonator without (with) the sample ΔQ_0 (ΔQ_t) – uncertainty of the Q-factor of the resonator without (with) the sample Example: $\Delta Q_0/Q_0 = \Delta Q_t/Q_t = \pm 0.01$, $Q_0 = 150{,}000$, $Q_t = 100{,}000 \rightarrow \Delta\sigma/\sigma \approx \pm 4.5\%$
Operational frequency range	20-50 GHz The upper frequency depends on the network analyzer employed.
Operational temperature range	Room temperature
Additional equipment needed to perform measurement	1. PC computer 2. Vector Network Analyser (e.g. Keysight, N5245A) OR scalar Q-Meter 3. LAN cable OR USB/GPIB interface, e.g. NI GPIB-USB-HS, USB 2.0, NI-488.2
Measurement procedure	The measurement is automated and controlled via dedicated software installed on a PC computer. At first, resonant frequencies and Q-factors of the $TEM_{0,0,q}$ even modes of the empty resonator are measured. Afterwards, a sample is inserted onto the holder and all the modes of interest are adaptively sought for in order to measure the Q-factor of the loaded cavity. The conductivity of the sample is obtained using a look-up table computed with a dedicated FPOR electromagnetic model.

Limitations & Accuracy characteristics



Minimum **thickness** of a sample to be measured with the FPOR-C system



FPOR Conductivity measurement error for a typical Q-factor measurement uncertainties ($\Delta Q/Q$ < 1%).