WEMA7

Fabry-Perot open resonator for single-sweep characterization of dielectric sheets in the 10-130 GHz range for 5G/6G applications

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(www.emarges.com)

About us

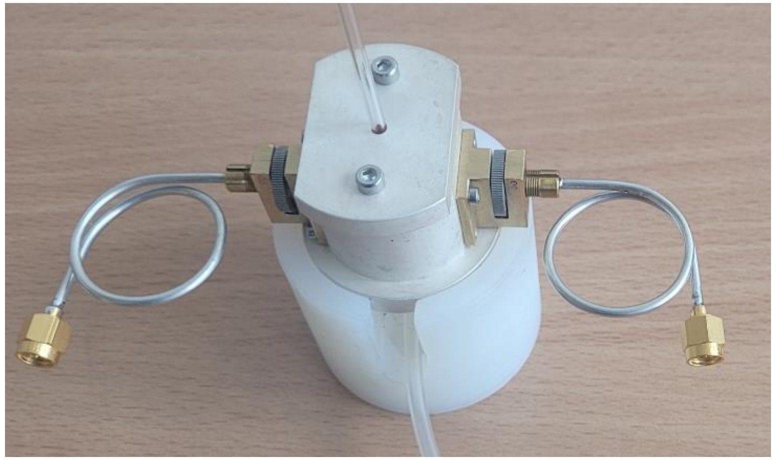
Origin: Spin-off at Warsaw University of Technology

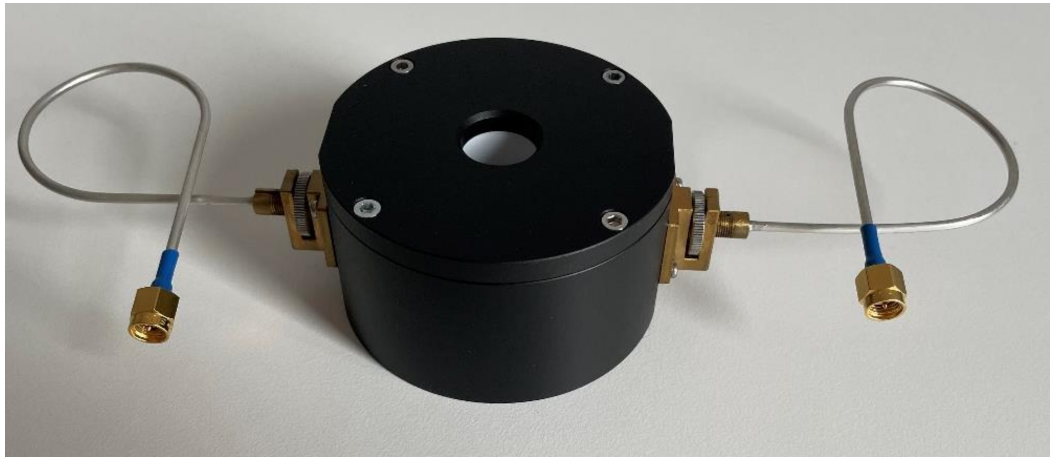
Location: Warsaw, Poland

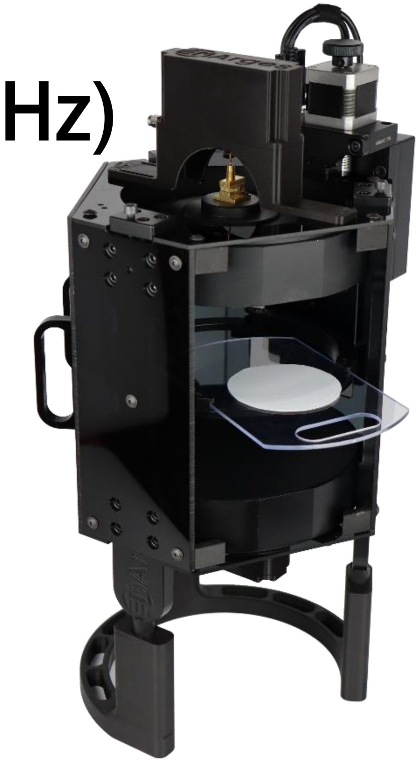
Size: SME

Main expertise: Resonant measurement methods (>1 GHz)

Main product: Fabry-Perot open resonator



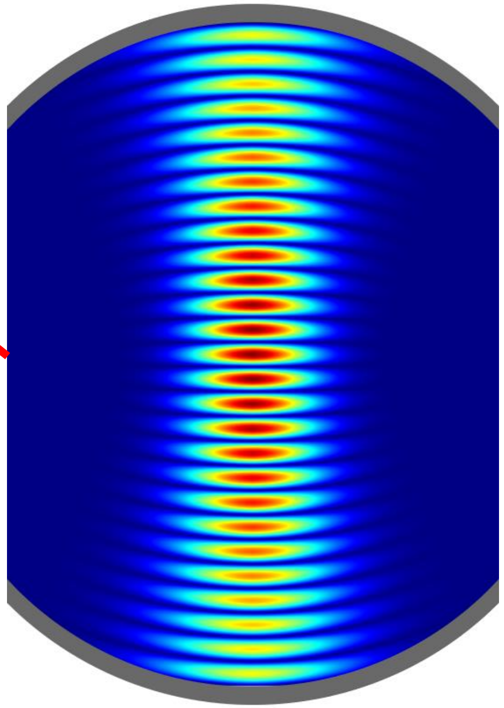




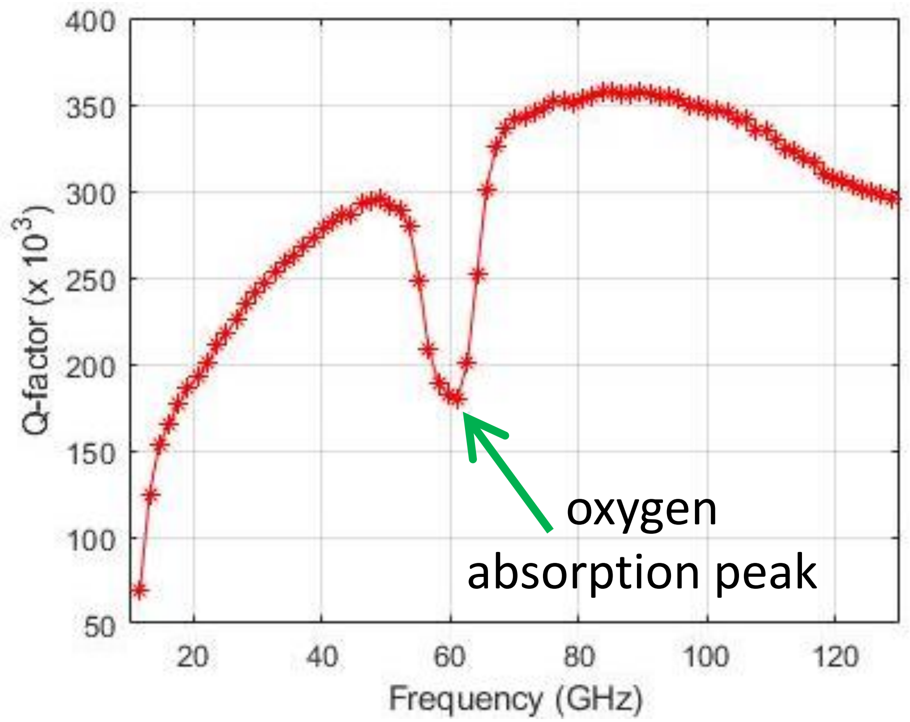
Fabry-Perot open resonator

- Multimode/**broadband** operation (10:1.5:130 GHz)
- Q-factor reaching 360k ($\tan\delta > 10^{-5}$ can be measured)
- Measurement time (ca. 5 minutes for 20-130 GHz)

10-130 GHz single-sweep system
with Keysight **coax-coupled** extenders



$TEM_{0,0,27}$
Gaussian mode

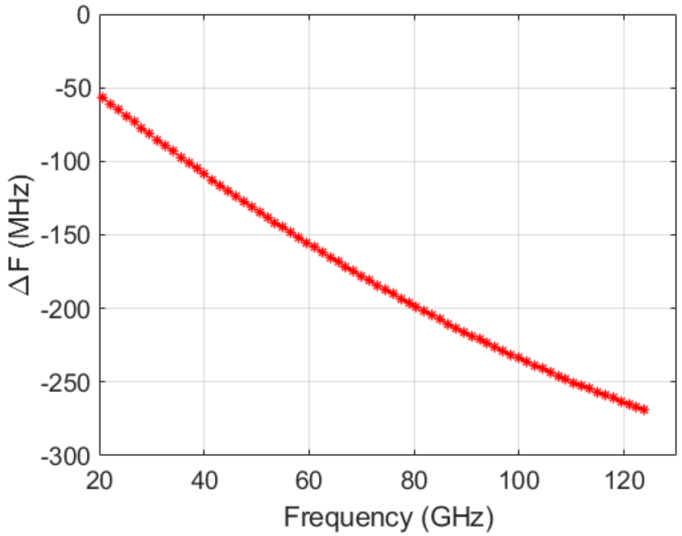


Q-factor
of the empty FPOR

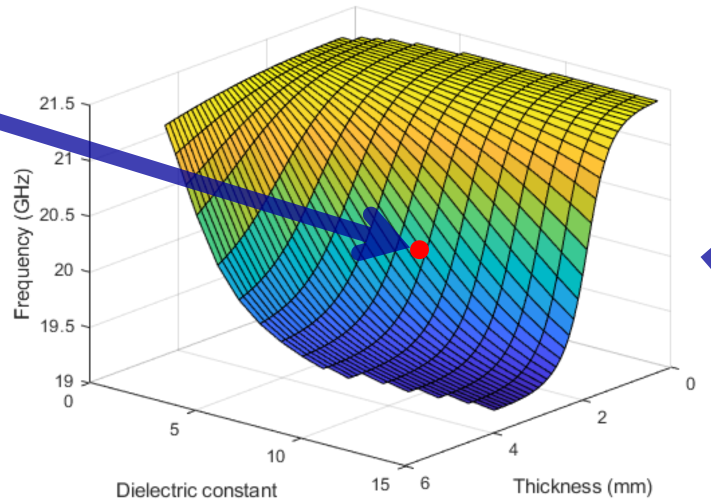
Dielectric constant

The choice of an electromagnetic model of the FPOR is essential

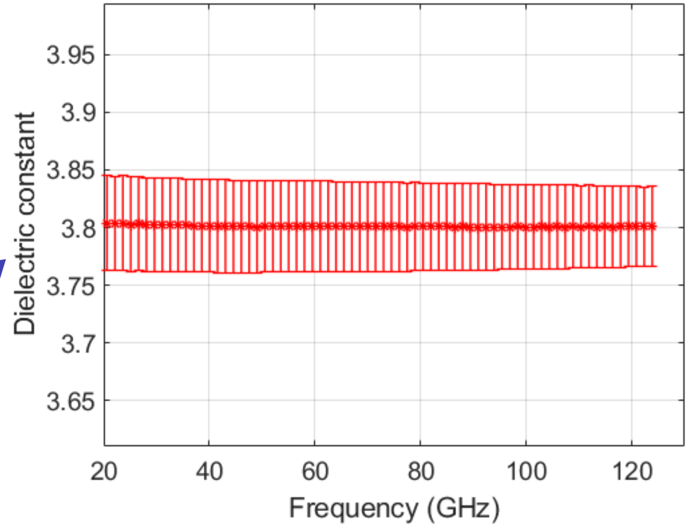
to get the dielectric constant with accuracy better than 0.5%



Measured frequency shift due to the sample



Look-up table computed with the scattering matrix method



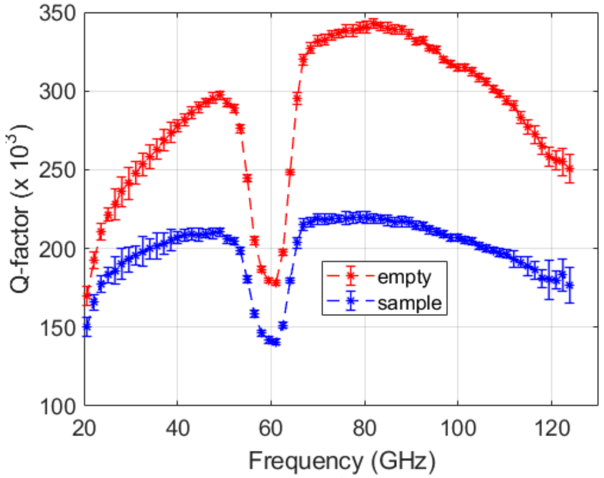
Fused silica

(t = 200 ± 3 μm)

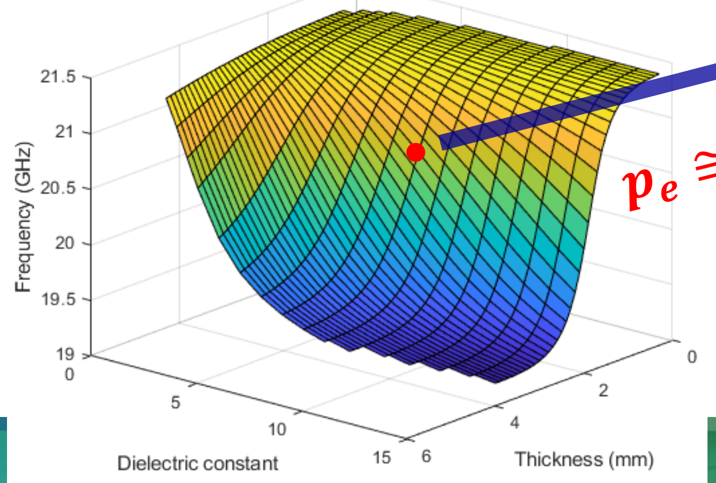
Loss tangent

Extremely large Q-factor of the empty FPOR makes it very sensitive

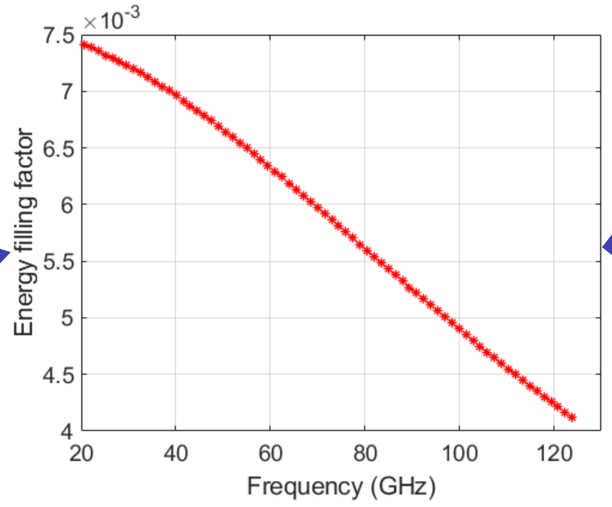
to dielectric losses of the sample ($\tan\delta > 10^{-5}$)



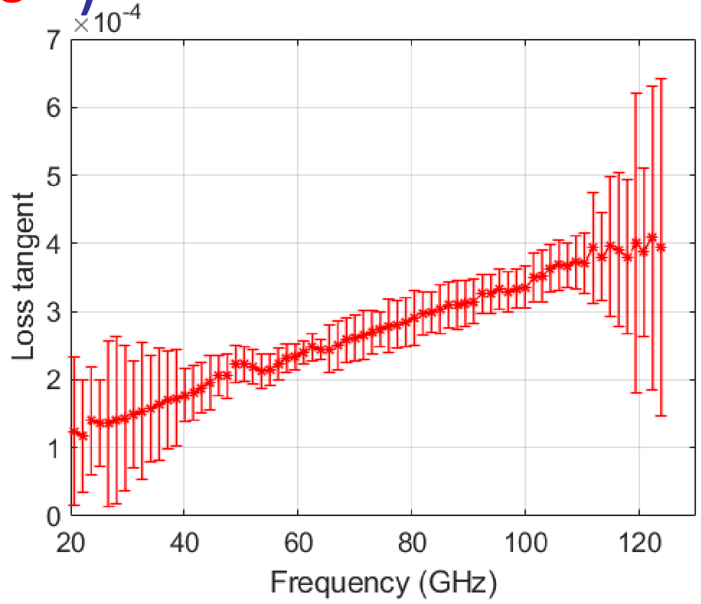
$$Q_t^{-1} = Q_0^{-1} + p_e \tan\delta$$



$$p_e \cong 2\left|\frac{\partial f}{\partial \varepsilon_r}\frac{\varepsilon_r}{f_s}\right|$$



Electric energy filling factor

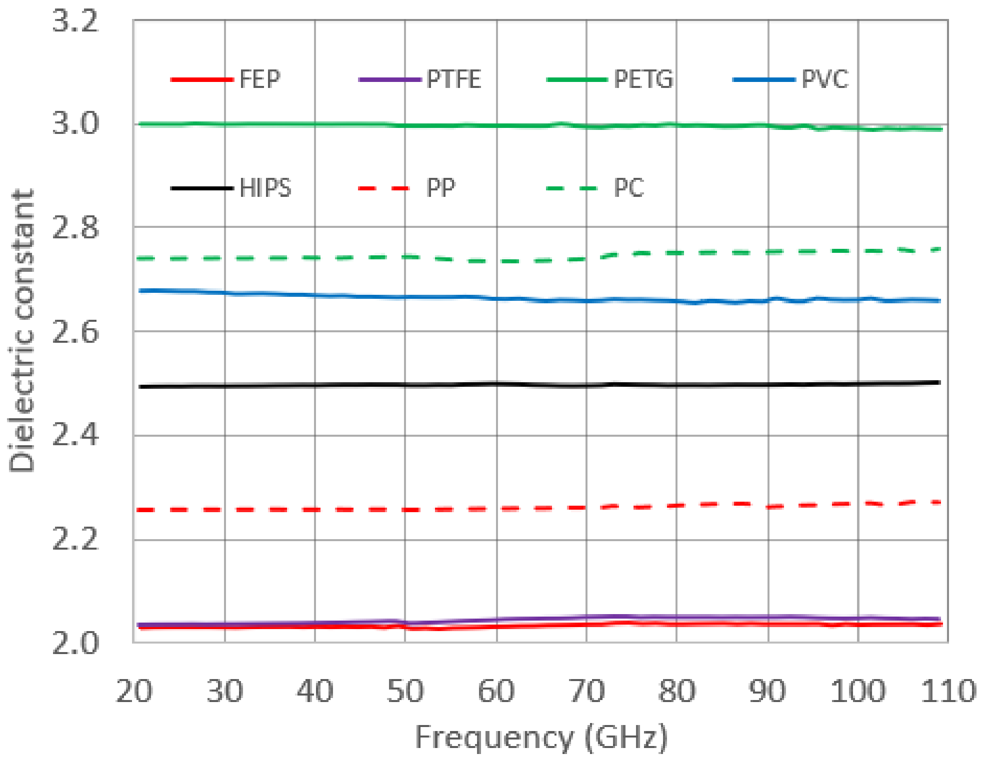


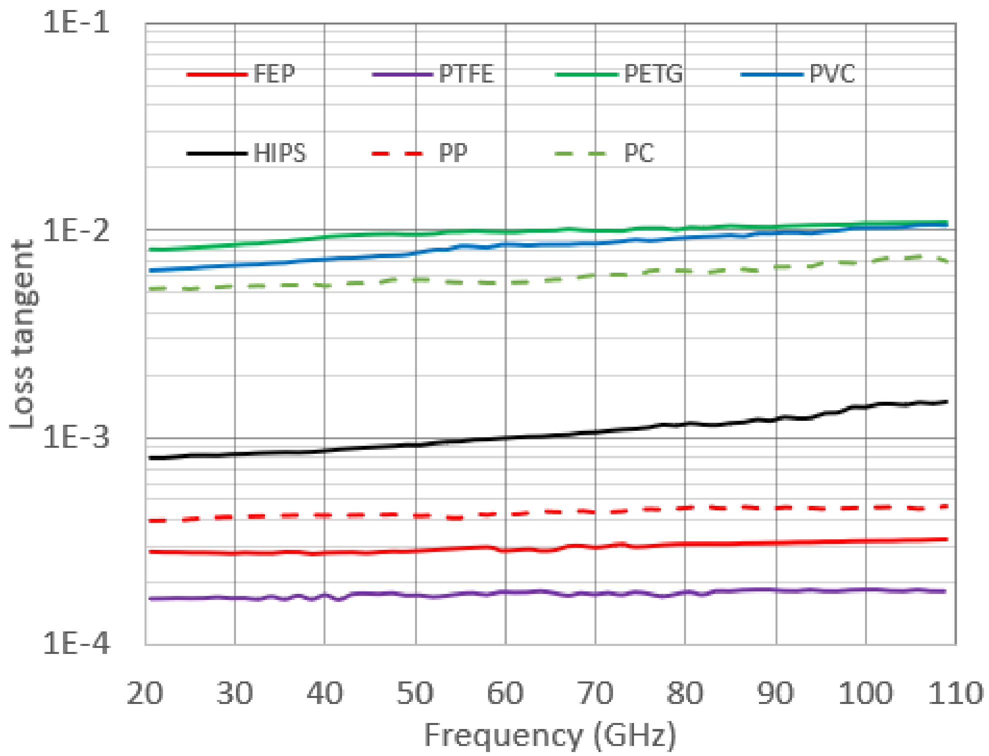
Fused silica

(t = 200 ± 3 μm)

Plastics

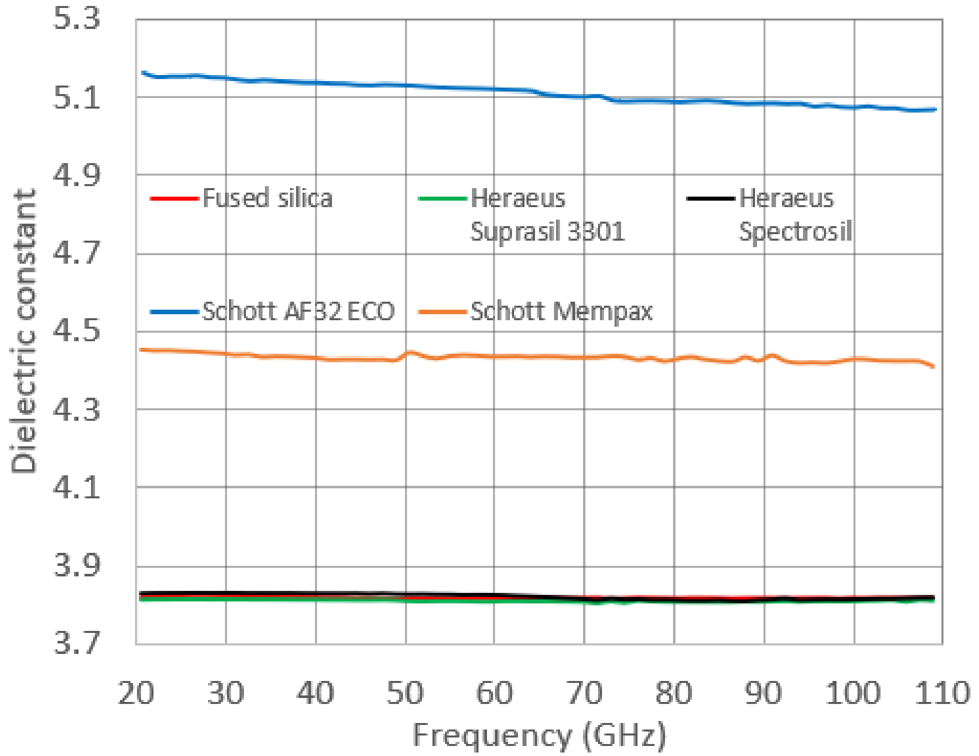
- **Typically: 2.02 (PTFE) < Dk < 3.5 (polyimide) - non-dispersive**
- **Typically: 2×10^{-4} (PTFE) < Df < 2×10^{-2} (polyimide) - barely dispersive**
- **Possible in-plane anisotropy due to technological reasons (e.g. stretching)**

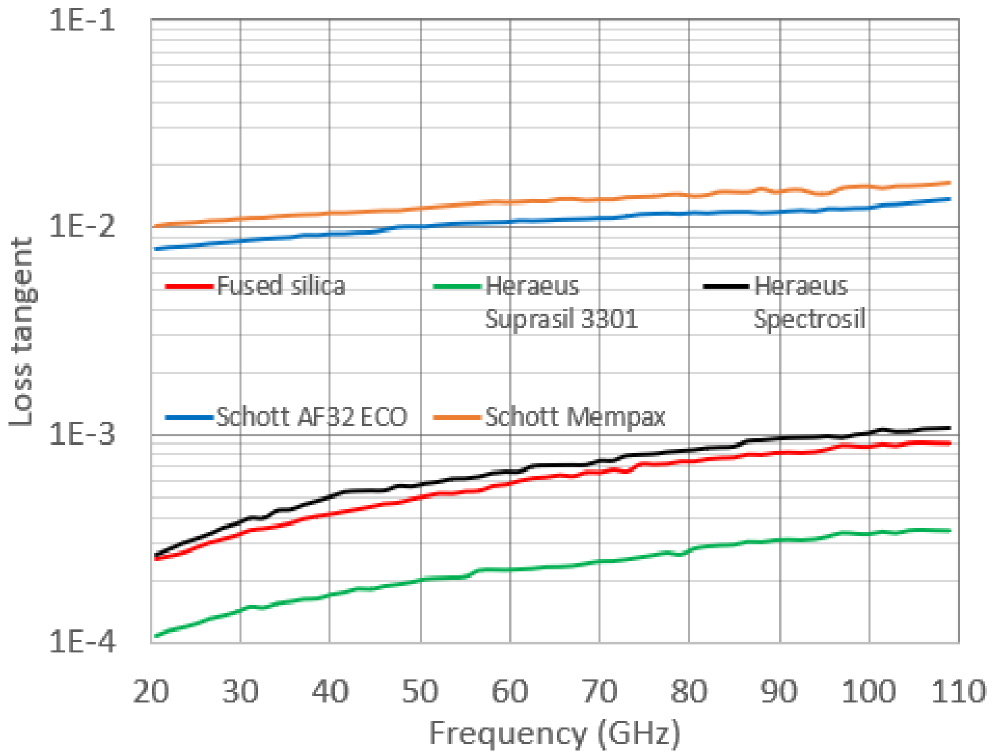




Glasses

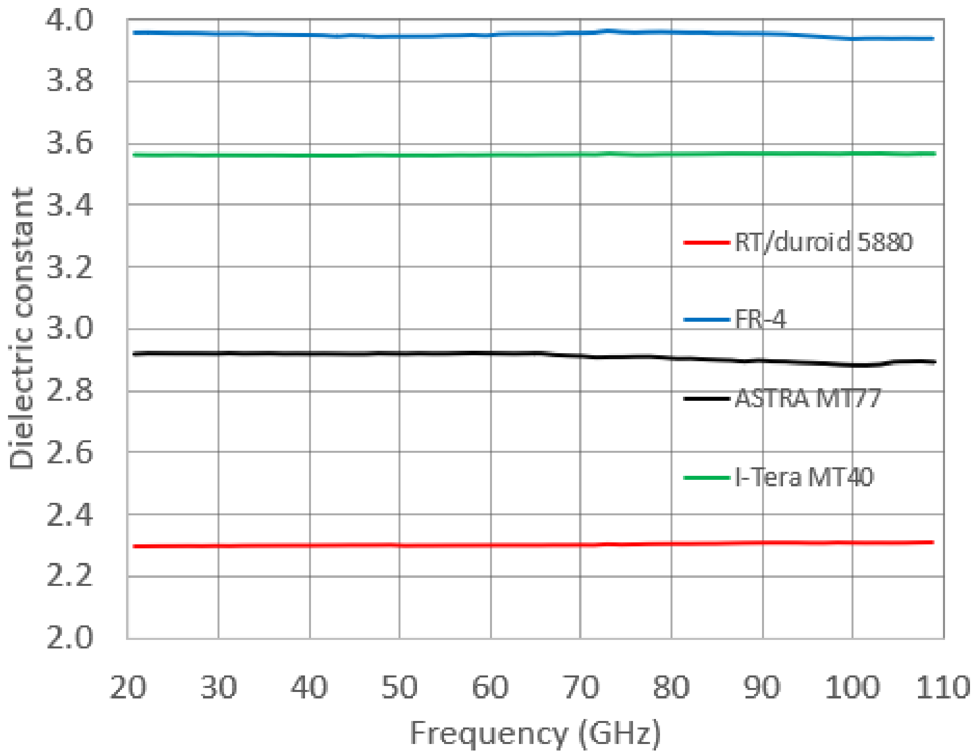
- **Typically: Dk > 3.8 (fused silica) - non-dispersive**
- **Typically: 10^{-3} (Heraeus Suprasil) < Df < 2×10^{-2} (Schott Mempax) - linear increase with freq**
- **Losses of fused silica strongly depends on the OH-content (production-dependent)**

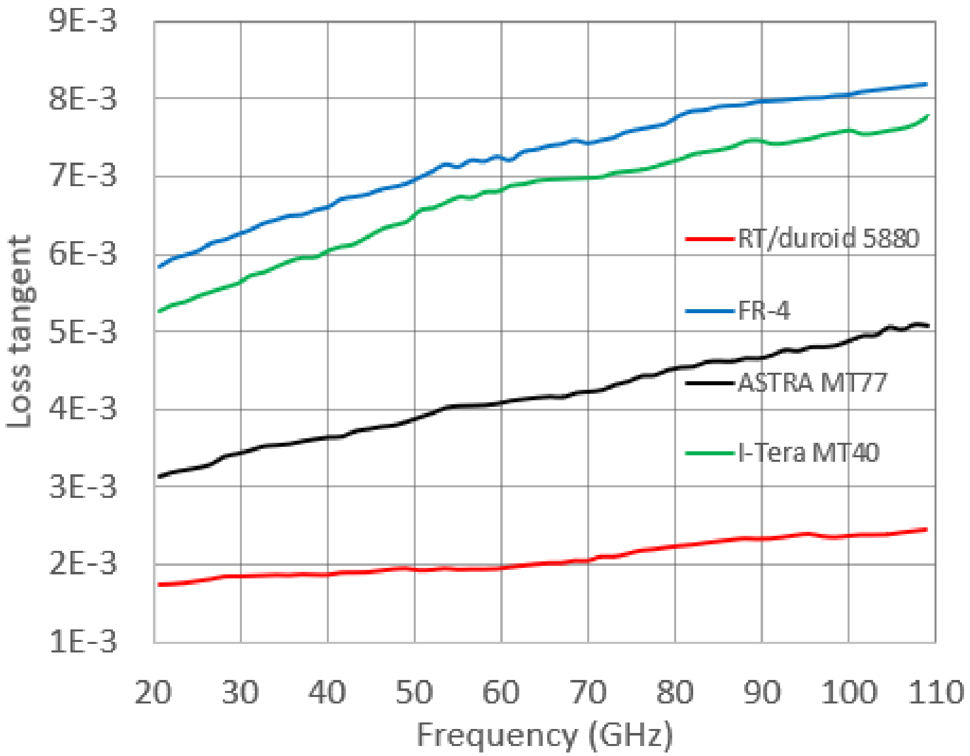




Low-Dk laminates

- Typically: 2.3 (RT5880) < Dk < 4 (FR4) - non-dispersive
- Typically: 10^{-3} (RT5880) < Df < 10^{-2} (FR4) - linear increase with frequency
- Glass fibers are one of major reasons for the loss increase with frequency



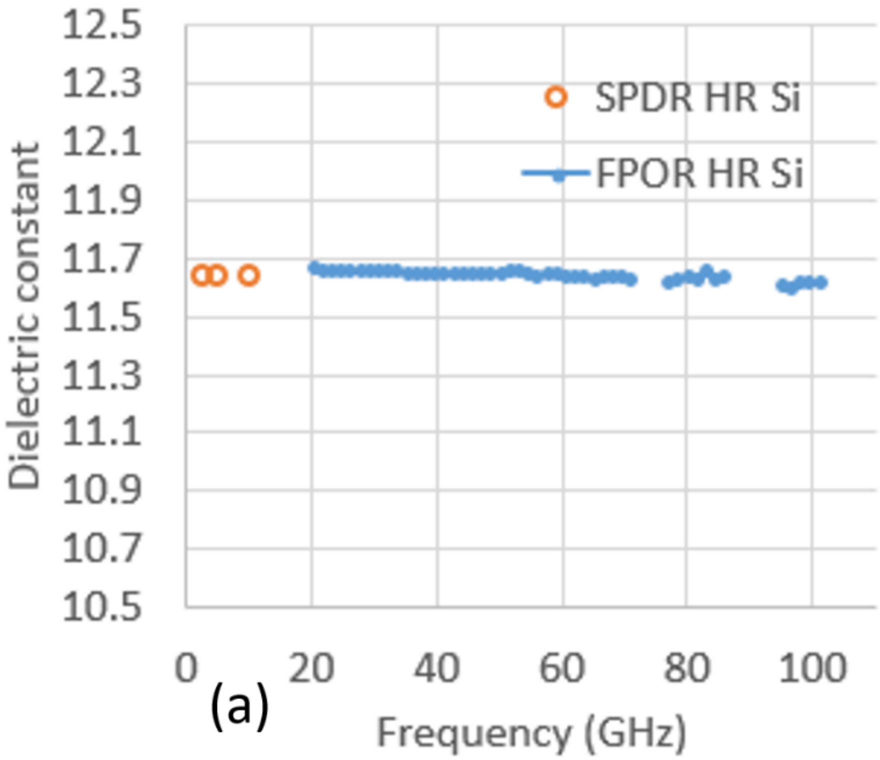


Semiconductors

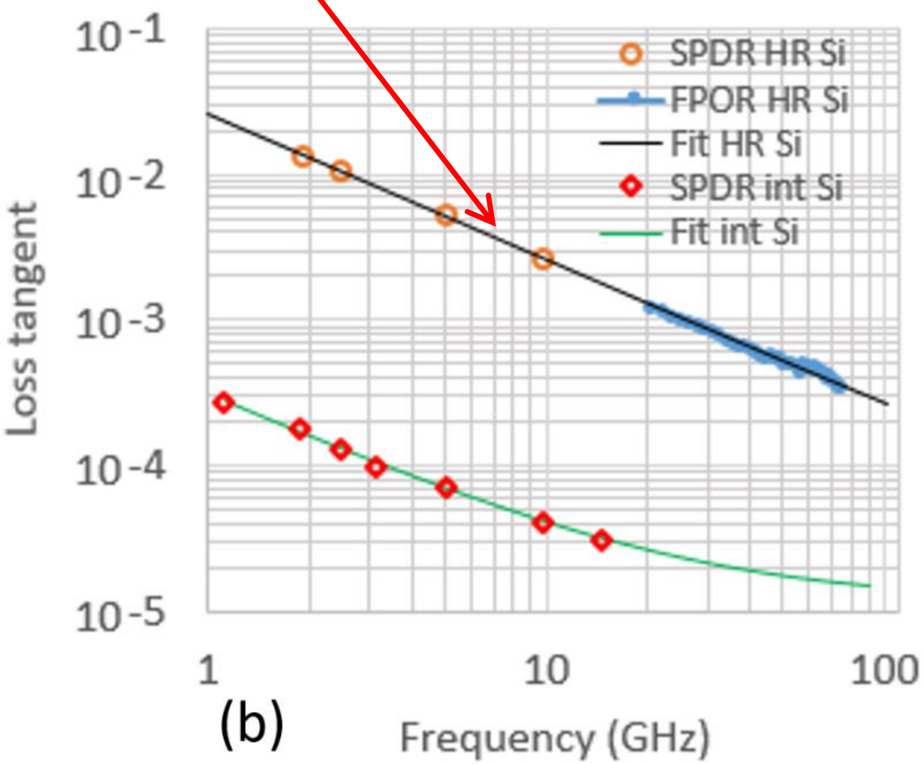
- Silicon: Dk = 11.65 - non-dispersive
- Silicon: Losses are mainly shaped by resistivity (ρ)

$$\tan\delta = 1.2 \times 10^{-5} + \frac{\rho^{-1}}{2\pi f \varepsilon_0 \varepsilon_r}$$

$$\rho = 6.09\ k\Omega cm$$

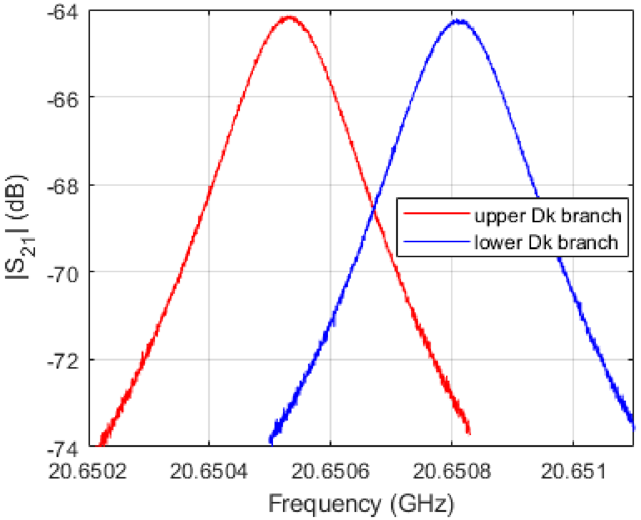


(a)



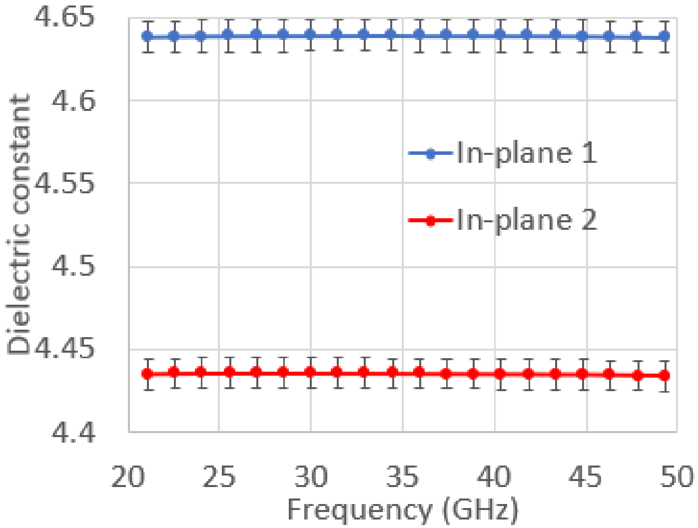
(b)

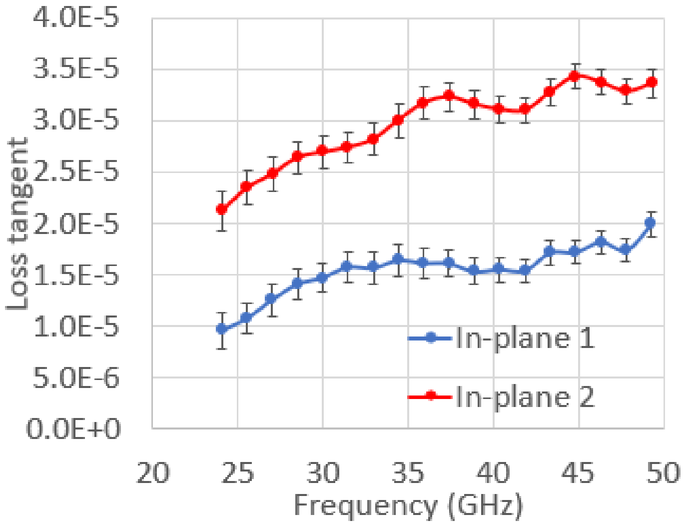
In-plane anisotropy



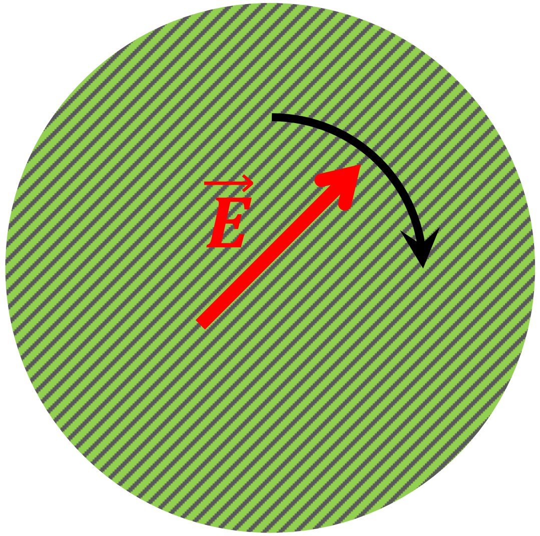
Transmission spectra

Measured twice

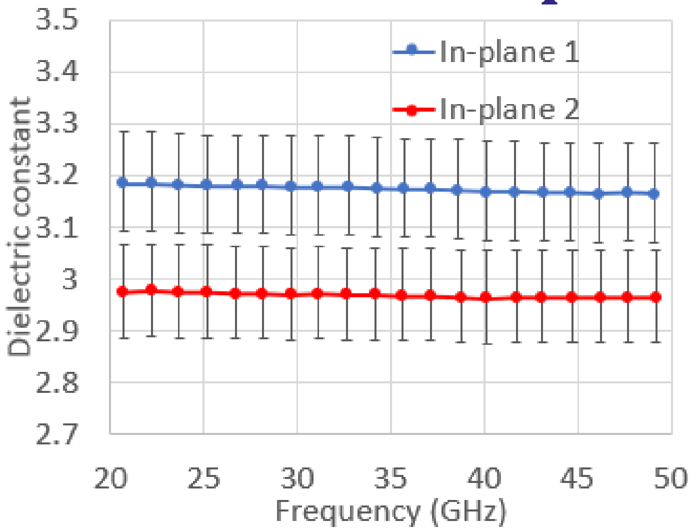


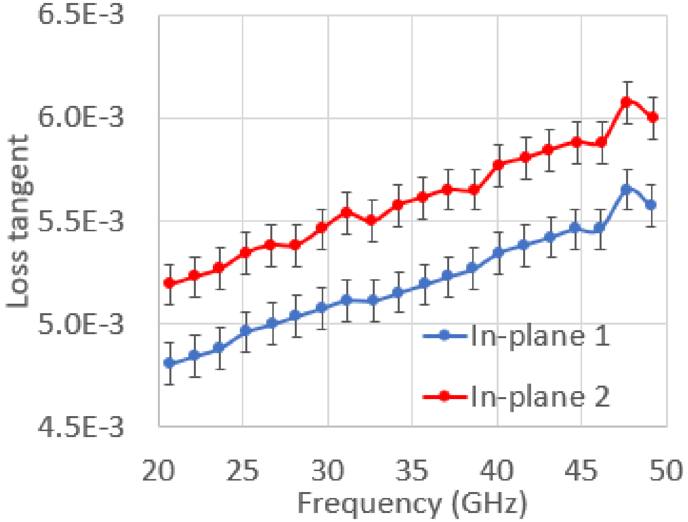


X-cut quartz (Thickness: 492 ± 1 μm)



Two orientations of the sample





PET foil (Thickness: 100 ± 3 μm)

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