Introduction to the Leibniz-Institut für Kristallzüchtung (IKZ)

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IKZ History and Facts

Address: Max-Born-Str. 2, 12489 Berlin-Adlershof, Germany

Direktor:
Prof. Dr. Thomas Schröder

founded 1992 from parts of the Academy of Sciences of the GDR

Member of the Leibniz Association
Funded by federal and state bodies

2017:
10.5 Million € basic funding
3.2 Million € third parties funding

about 125 employees:
4 Professors/University lecturers
47 scientists
22 PhD students
6 master/bachelor students
47 Technicians/administration staff

Mission:

- **Science and Technology Development** of crystal growth, preparation, and physical/chemical characterisation of crystalline solids,
- **Research and Delevopment of Materials** for both new and matured applications,
- Preparation of unique/benchmark crystals,
- Provision of crystals and samples for the community

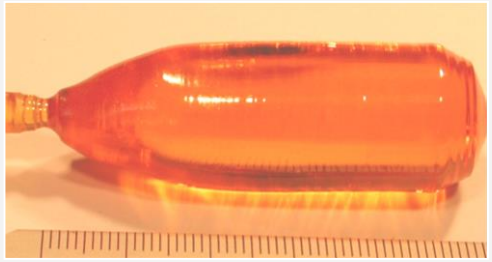
Goals:

- Publications and lectures
- Patents
- Technology transfer towards industry
- Education and training

IKZ areas of activity

cm → **µm** → **nm**

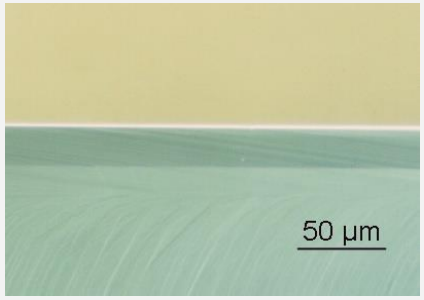
Bulk & Fibers



$SmScO_3$ single crystal

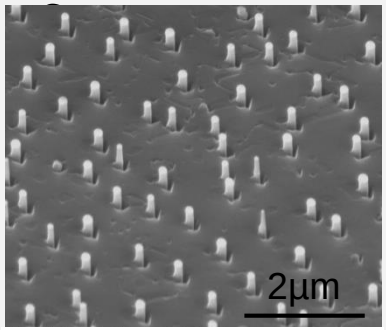
$Cr:Al_2O_3$ fiber

Epitaxial layers



4H-SiC epilayer

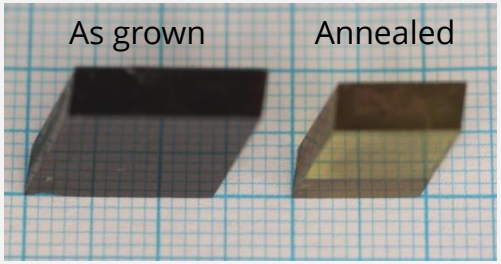
Nanostructure



Si nanowires

Element crystals → **Compound semiconductors** → **Dielectrics and lasers**

8“ FZ Silizium

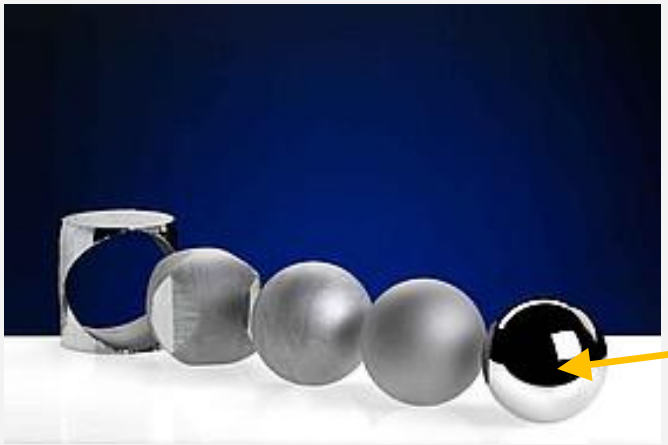


10x10 mm² In_2O_3

Ø10 mm AlN

Ø35 mm $Cr:LiCaAlF_6$

IKZ Highlights: Silicon



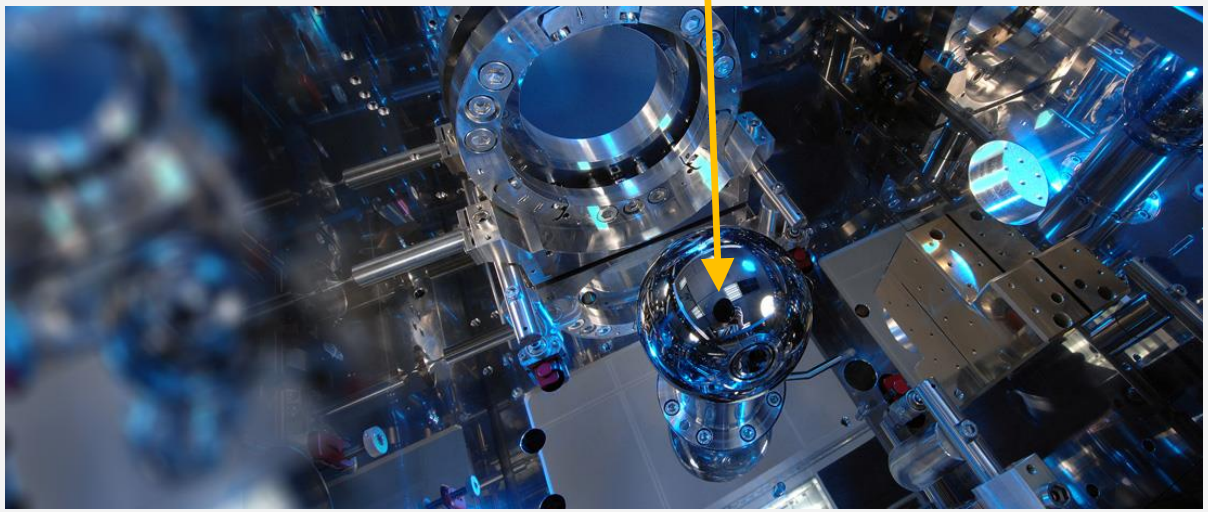
Re-definition of the kilogram:

– isotopically pure Si

– perfect latice constant

– perfect sphere

$$m_{Kugel} \overset{def}{=} 1\ kg$$



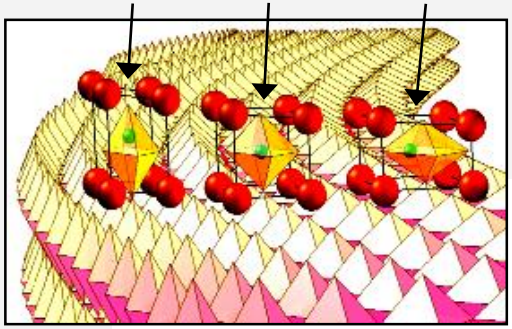
Messen ▪ Forschen ▪ Wissen

Homepage PTB Avogadro-Projekt:
https://www.ptb.de/cms/ptb/fachabteilungen/abt3/fb-34/ag-344.html

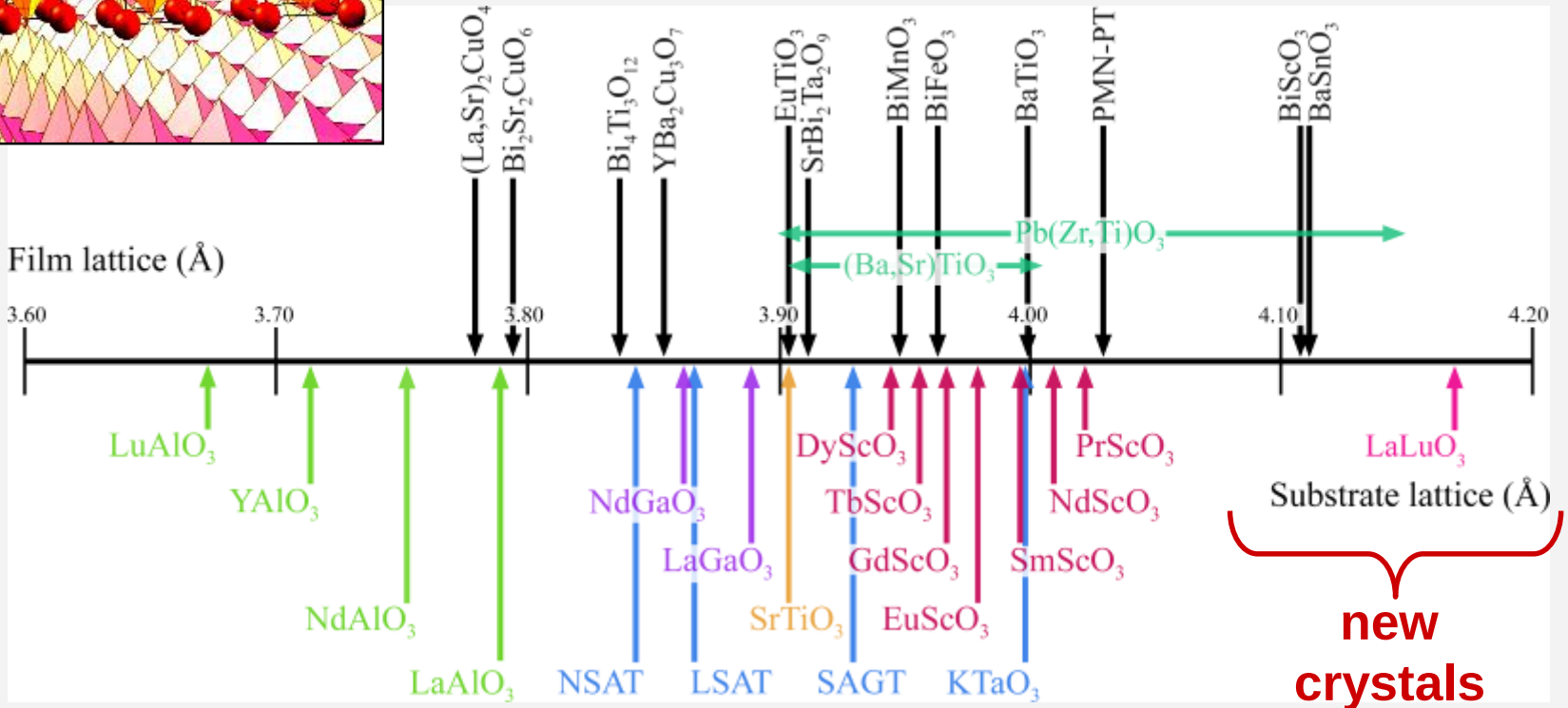
Scientific Departments:

- Classical semiconductors (Si, Ge, GaAs)
- Dielectrics and Wide Bandgap Materials (Oxides, Fluorides, Nitrides)
- Layers and nanostructures (functional and semiconducting oxides)
- Simulation & Characterization (physical, chemical, structural)

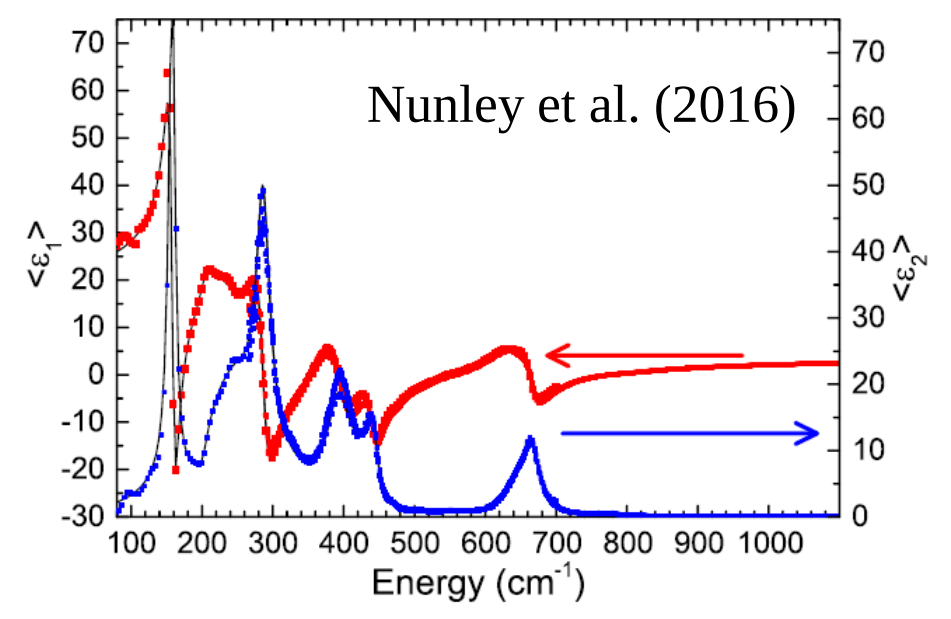
perovskite layer in-plane strain
compressed relaxed tensile



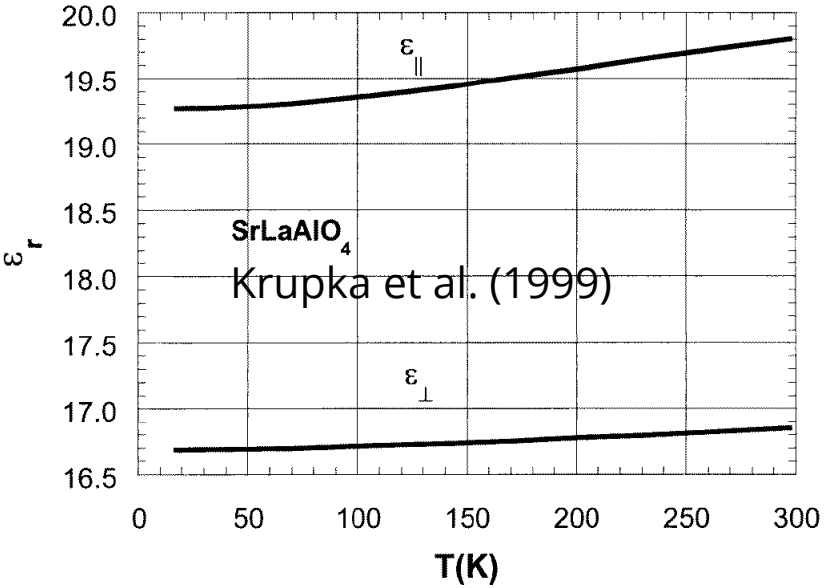
Substrates with Perovskite Structure



Optical constants of LSAT



$SrLaAlO_4$

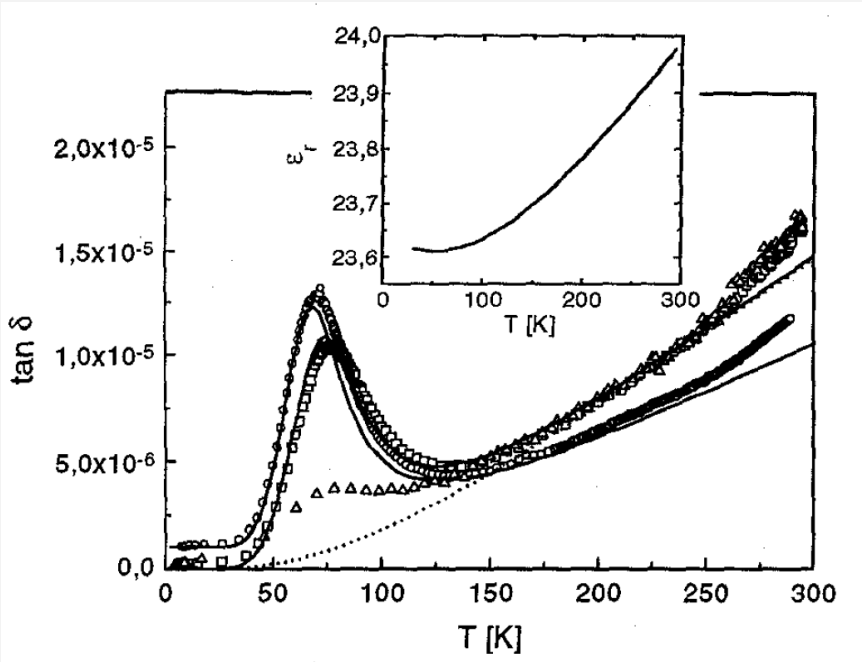


- The presence of specific phonons in perovskite oxides result in materials with high dielectric constants
- Anisotropic materials have anisotropic dielectric constants

Factors affecting the loss tangent:

- Phonon occupation
  - Temperature
  - Frequency
  - Phonon density of states
- Point defects
  - Temperature
  - Frequency
  - Type of defect

$LaAlO_3$ loss tangent



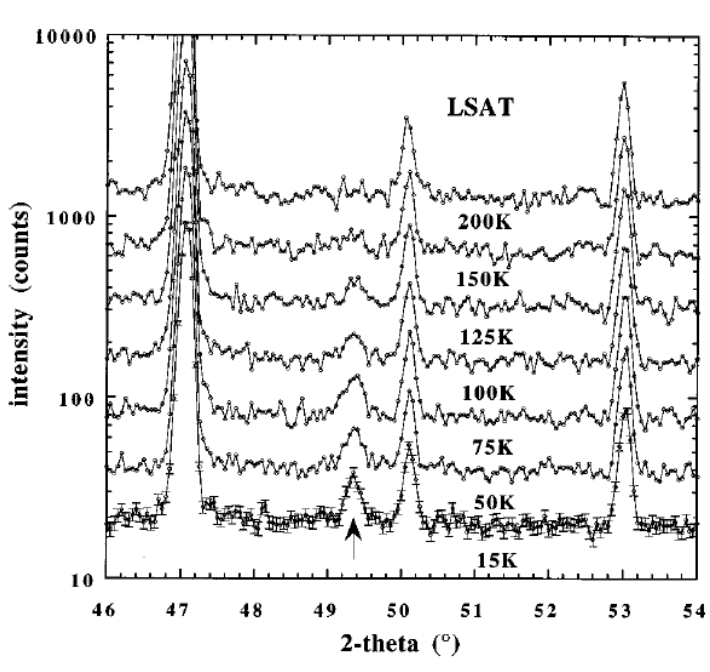
Zucarro et al. (1997)

Electrical properties of $LaAlO_3$ are fine, but...
... rhombehral structure → twinning
... mismatch between required crystall volume and current day production
... high melting point 2080 °C

Crystal growth of LSAT is more favorable
... melting point of 1840 °C
... no phase transition between growth temperature and room temperature

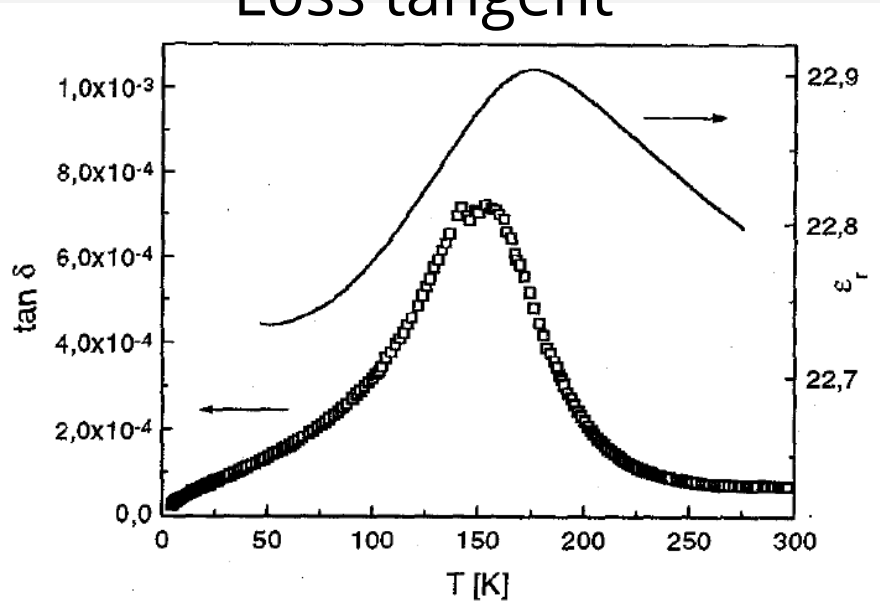
LSAT

Neutron diffraction



Chakoumakos et al. (1998)

Loss tangent



Zucarro et al. (1997)

Possible optimization of LSAT loss by controlling the phase transition

How can IKZ contribute to MADMAX?

Expertise in crystal growth

- Growth and supply of LSAT crystals (with diameters of about 30 mm) for fundamental investigations
- Help in finding potential industry partners (for example FEE or Crytur) in order to discuss the prospects of an industrial mass production

Expertise in the characterization of crystals

- Structural characterization of crystals using XRD/TEM
- Determination of crystal compositions (ICP-OES, in 2019)
- Optical spectroscopy for point defect characterization
- Raman + FTIR measurement in order to determine phonon frequencies
- Cutting and surface preparation of crystals
- Growth of superconducting films for performing dielectric measurements