

Satellite Meeting on Time-Resolved Ellipsometry
12th Workshop on Spectroscopic Ellipsometry
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Perspective on Femtosecond Ellipsometry



AVS 2022, Pittsburgh, PA

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Ask me about MS/Ph.D. student positions at NMSU.



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Historical Perspective on Transient Ellipsometry

D.H. Austin & C.V. Shank, Phys. Rev. Lett. 1974 (single-wavelength).

G.E. Jellison & D.H. Lowndes, Appl. Opt. 1985.

M.C. Downer, Appl. Phys. Lett. 1993.

Boschini, Rev. Sci. Instrum. 2015 (white light probe).

Shirly J. Espinoza-Herrera, Bastian Besner, Jakob Andreasson,
VUV pump-probe **magneto**-optical ellipsometry at ELI Beamlines,
DPG Frühjahrstagung Regensburg, 7 March **2016**

Current configuration:

Pump beam with 800/400/267 nm, 1 kHz rep rate
(tunable pump energy now also available).

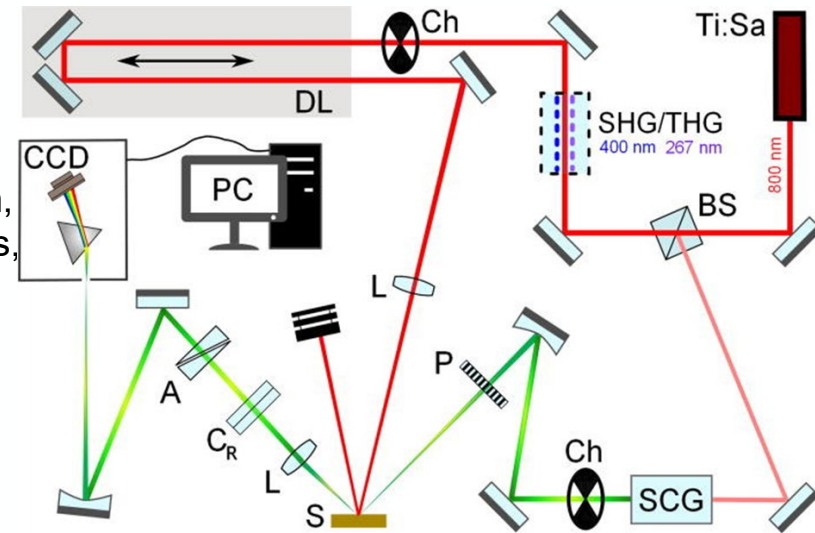
White light probe beam 350-750 nm at 60 degree AOI.

Rotating compensator ellipsometer.

35 fs pump pulses, 120 fs time resolution (geometry).

Very long delay line (6.7 ns) with 3 fs resolution.

Measurements in magnetic field under development (Martin).



What have we accomplished ???

- **ZnO** (Steffen Richter, Oli Herrfurth, Rüdiger Schmidt-Grund, ...)
New Journal of Physics, 2020; Phys. Rev. Res. 2021
- **Ge, Si, GaAs** (Shirly Espinoza, Mateusz Rebarz, Carola Emminger, Stefan Zollner, ...)
Applied Physics Letters, 2020; physica status solidi RRL, 2022
- **LaCoO₃** (Martin Zahradnik, ..., Adam Dubroka)
Phys. Rev. B 2022
- **Phase change material Sb₂S₃** (Yael Gutierrez, ..., Kurt Hingerl, Maria Losurdo)
Thin Solid Films 2023
- **Cubic GaN** (Elias Baron, Rüdiger Goldhahn, ..., Martin Feneberg)
J. Appl. Phys. August 2023 (two papers)
- **GaP, ScN** (Noah Stiehm, Younes Slimi, ..., Rüdiger Schmidt-Grund, Stefan Krischok)
- **Surface plasmon polaritons in gold** (Zsuzsanna Papa, Judith Budai, ...)
- Two **AKE Paul Drude awards** (Steffen Richter, Carola Emminger)
- Several **invited talks** at conferences (ISPSA-Korea 2022, DPG 2023, Fall MRS 2023)

What processes have been studied ???

- Interband and intraband transitions, relaxation, recombination
- Intervalley scattering ($\Gamma \leftrightarrow L$, $\Gamma \leftrightarrow X$, $L \leftrightarrow X$) mediated by phonon scattering.
- Band filling (Pauli blocking, bleaching), Burstein-Moss shift
- Screening of the excitonic (Sommerfeld) enhancement
- Band gap renormalization (true many-body BGR without ionized impurity effects)
Fermi-level singularity in Ge
- Carrier diffusion (GaN)
- Transient birefringence and dichroism (ZnO)
- Phonon oscillations (Ge, GaP)
- Insulator-to-metal (Mott) transition (LaCoO_3)
- Reversible dynamics near phase transitions (PCM Sb_2S_3)
- *Chemical reactions (not aware of any studies)*

What's next ???

- What will we learn from measurements in a magnetic field?
- What will we learn with a tunable pump laser (250 to 2500 nm)?
- Temperature dependence of ultrafast processes
- What are the pump pulse limitations? Duration?
- What are the white light probe pulse limitations?
Is there a broadband IR or UV source?
- Can we improve time resolution despite oblique incidence angle?
- VUV pump or probe measurements using high-harmonic source
- New applications of existing measurements?
- Ultrafast imaging
- Creative pump/probe configurations (Kretschmann geometry)

Thank you!

**What's
next?**