Angle-resolved Generalized Ellipsometry:
Form-birefringent chiral and non-chiral silicon sculptured thin films

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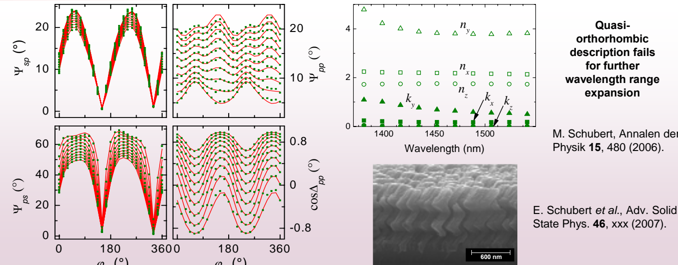
Our message

- Generalized Ellipsometry permits analysis of intrinsic axes and response functions in dielectric anisotropic materials, regardless of symmetry (tetragonal, orthorhombic, triclinic).
- New material classes emerge with nano structure thin film fabrication.
- 3D angle-resolved spectroscopic Mueller matrix studies identify new optical signatures beyond dielectric anisotropy in nano structured chiral silicon thin films.
- Symmetry violation, which cannot be explained by dielectric birefringence, hints to necessary introduction of chiral tensor description (optical activity = bianisotropy).

Quasi-orthorhombic description for silicon chevron

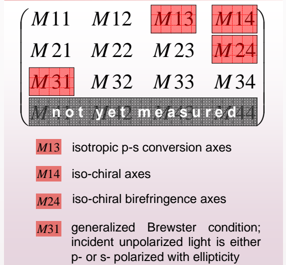


Quasi-orthorhombic description fails for further wavelength range expansion

M. Schubert, Annalen der Physik **15**, 480 (2006).

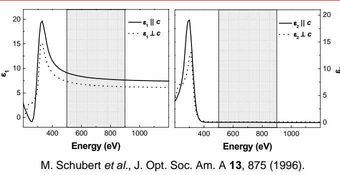
E. Schubert *et al.*, Adv. Solid State Phys. **46**, xxx (2007).

3D Mueller matrix image

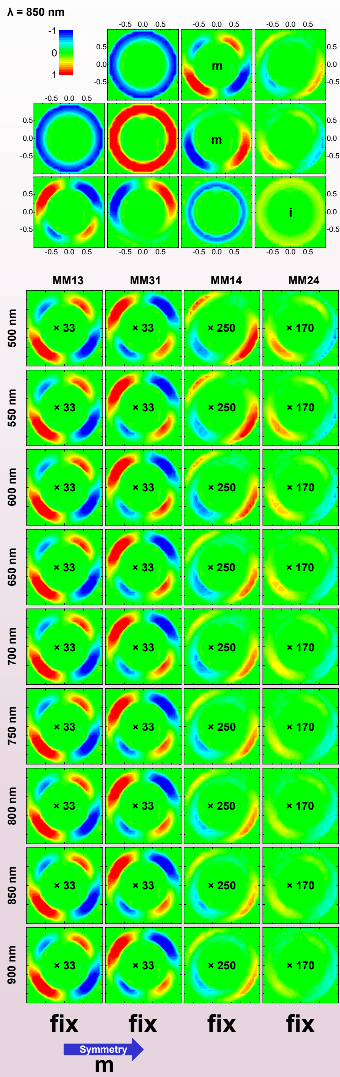


- M13: isotropic p-s conversion axes
- M14: iso-chiral axes
- M24: iso-chiral birefringence axes
- M31: generalized Brewster condition; incident unpolarized light is either p- or s- polarized with ellipticity

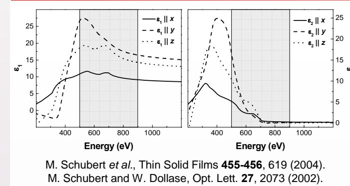
Rutile (111) surface
(tetragonal; α = β = γ = 90°)



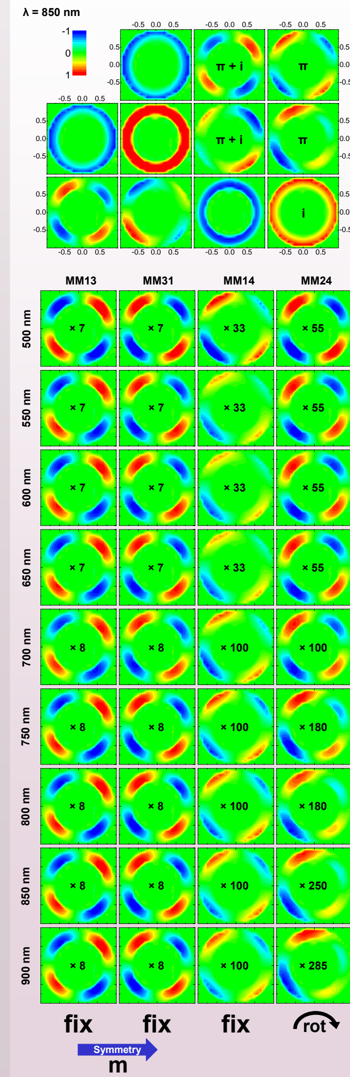
M. Schubert *et al.*, J. Opt. Soc. Am. A **13**, 875 (1996).



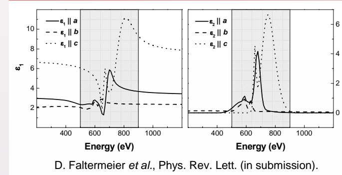
Stibnite (313) surface
(orthorhombic; α = β = γ = 90°)



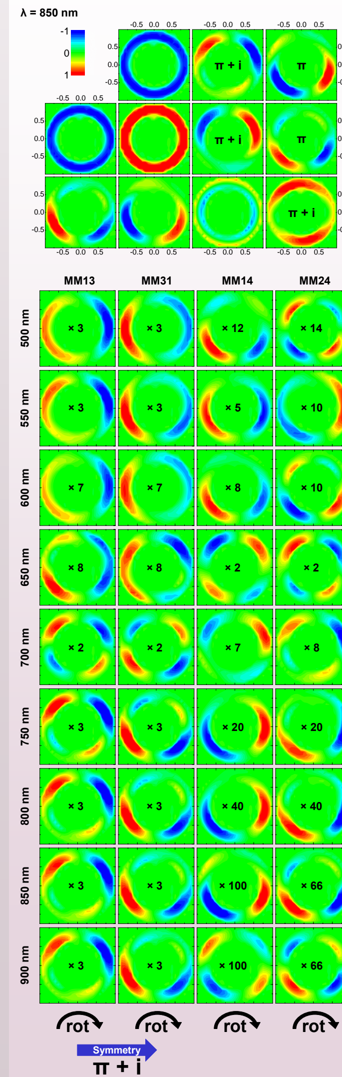
M. Schubert *et al.*, Thin Solid Films **455-456**, 619 (2004).
M. Schubert and W. Dollase, Opt. Lett. **27**, 2073 (2002).



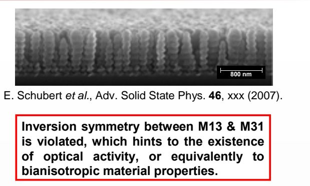
Pentacene (011) surface
(triclinic; α ≠ β ≠ γ ≠ 90°)



D. Faltermeier *et al.*, Phys. Rev. Lett. (in submission).

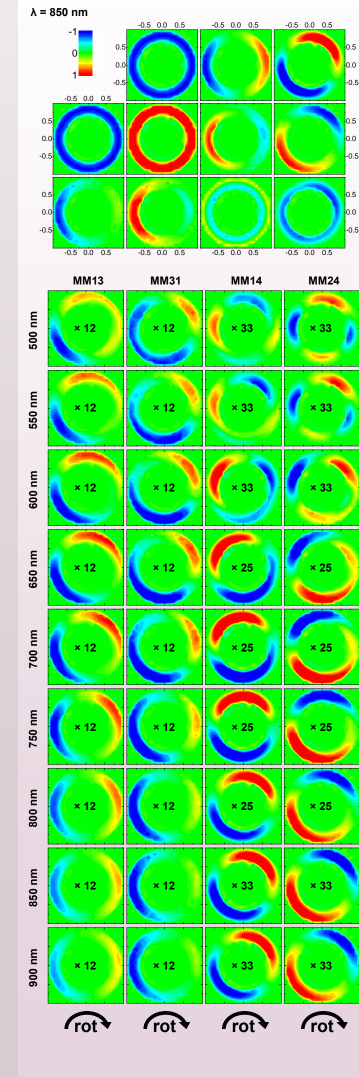


Silicon nano spirals
(pseudo-triclinic + chiral)



E. Schubert *et al.*, Adv. Solid State Phys. **46**, xxx (2007).

Inversion symmetry between M13 & M31 is violated, which hints to the existence of optical activity, or equivalently to bianisotropic material properties.



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