

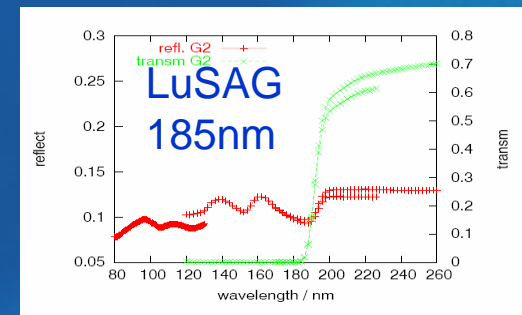
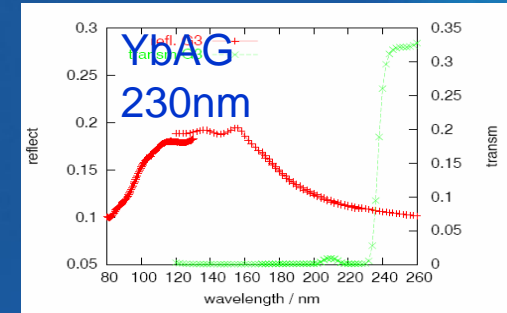
Schott Lithotec Update on High Index Lens Materials

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High Index Materials – most promising candidate is LuAG

- ▶ Based on a screening study and checking of the intrinsic properties SL introduced LuAG as the main candidate at the Immersion Symposium 2005 in Bruges
- ▶ LuAG potential confirmed by NIST at SPIE Microlithography 2006
- ▶ Among Al-based garnets found no other option with higher bandgap!
- ▶ Presently no real alternative to LuAG (crystal or ceramics) with manufacturability potential identified



	Refractive Index @ 193 nm	Manufacturability	IBR	Transmission	Homogeneity SBR	Fluid resistance
$\text{Lu}_3\text{Al}_5\text{O}_{12}$	n = 2,1	Up to 80 mm diameter in optical quality Scalability ?	30 nm/cm	High purity raw materials available	YAG as grown is Factor 3-10 above spec	

Feasibility of LuAG – main showstoppers and critical developmental areas

▶ Main showstoppers

- Transmission very critical due to the near absorption edge (178nm) of LuAG compared to the operation wavelength @193nm
- Behaviour of LuAG under Excimer Laser irradiation is completely unknown

➔ SCHOTT Lithotec started a feasibility study in 12/05 to evaluate these critical showstoppers

▶ Critical developmental areas

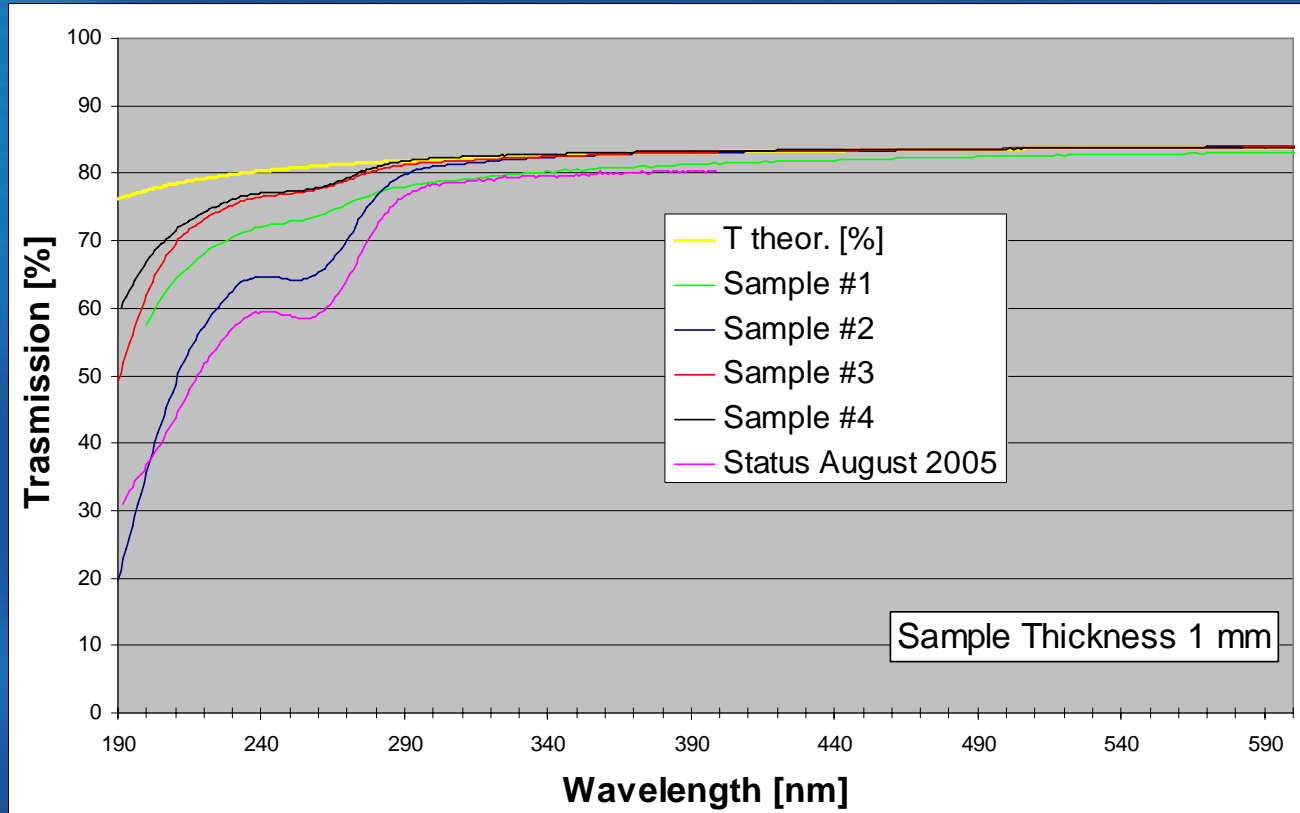
- Up scaling to required lens size (150 –200mm)
- Annealing technology for improvement of stress birefringence and homogeneity must be developed and introduced

Impacts on Transmission and Laser Durability

Root cause analysis used for Design of Experiments (DOE) in the Feasibility Study

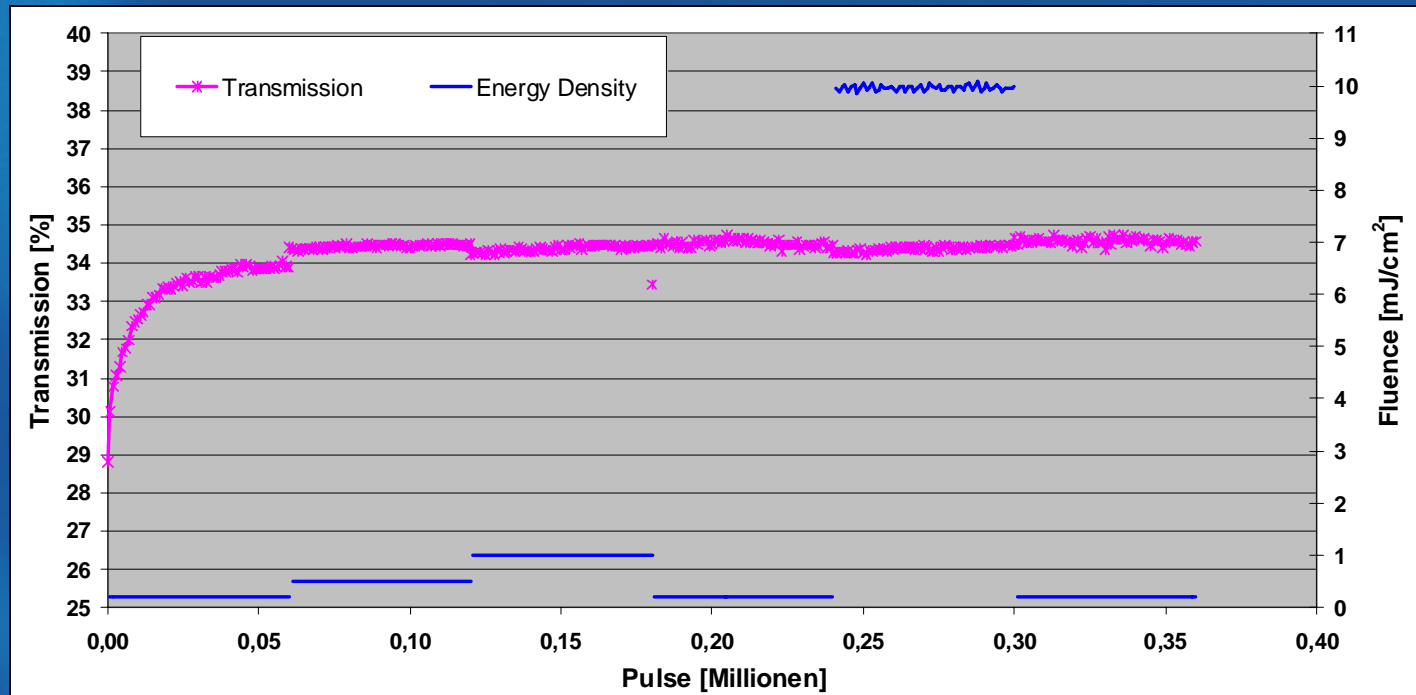
- ▶ Raw Materials
 - Rare Earths with polyvalence – charge transfer (Yb, Ce, ...)
 - Transition Metals (Fe, Cr, ...)
- ▶ Intrinsic Defects
 - Vacancies, color centers
 - Anti-sites ($\text{Lu}_{\text{Al}}^{3+}$, $\text{Al}_{\text{Lu}}^{3+}$)
- ▶ Crucible
 - Alloy components, impurities (Ir, Fe, Cr, Nb, ...)
- ▶ Insulation
 - Heat insulation materials (ZrO_2 – granulates, mats)
- ▶ Atmosphere
 - Oxidation/Reduction of crucible material

Feasibility Study Results - Transmission



- ▶ Results obtained from random DOE using different process/materials conditions
- ▶ Use of available highest purity raw materials (nominal 6N) leads to a significant improvement of transmission ($@193\text{nm} < 1.0 \text{ cm}^{-1}$)

Feasibility Study Results – Laser durability findings



- ▶ No significant degradation under ArF laser irradiation was found, despite of relatively low transmission
- ▶ Laser durability might not be the showstopper!

Commercialization/Proposal

- ▶ Commercialization Challenges
 - Technical risks of development
 - Competing technologies (EUVL,...)
 - Limited utilization

- ▶ Proposal to exposure tool makers
 - After successful development SCHOTT Lithotec to set up production site as profit center
 - Profit center costs + 15% margin for SCHOTT Lithotec to be shared by exposure toolmakers

Summary - Outlook

- ▶ Feasibility Study Results (available in a few weeks)
 - Transmission and durability potential of LuAG will become more predictable for a full-scale development
- ▶ SCHOTT Lithotec might continue with additional feasibility work and full development of LuAG
 - Transmission and durability will not continue to represent showstoppers
 - Timing of remaining work for LuAG introduction fits to the roadmap for Hyper NA tools

Acknowledgments

- ▶ Participants to LuAG Feasibility Study addressing Transmission and Laser Durability

Canon Inc.

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Nikon Corporation