Joint ExoPAG/COPAG Technology Development Possibilities: Coatings

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Objective

Develop and characterize reflective coatings for future use with a 4-8-m class telescope, for a joint mission devoted to

- ultraviolet astronomy, *and*
- direct imaging of exoplanets.

Requirements:

- high reflectivity in the UV-VIS ranges, i.e., 1000 to 10,000 Angstroms
- small polarization phase shift in the VIS
- durability.

Benefits to community

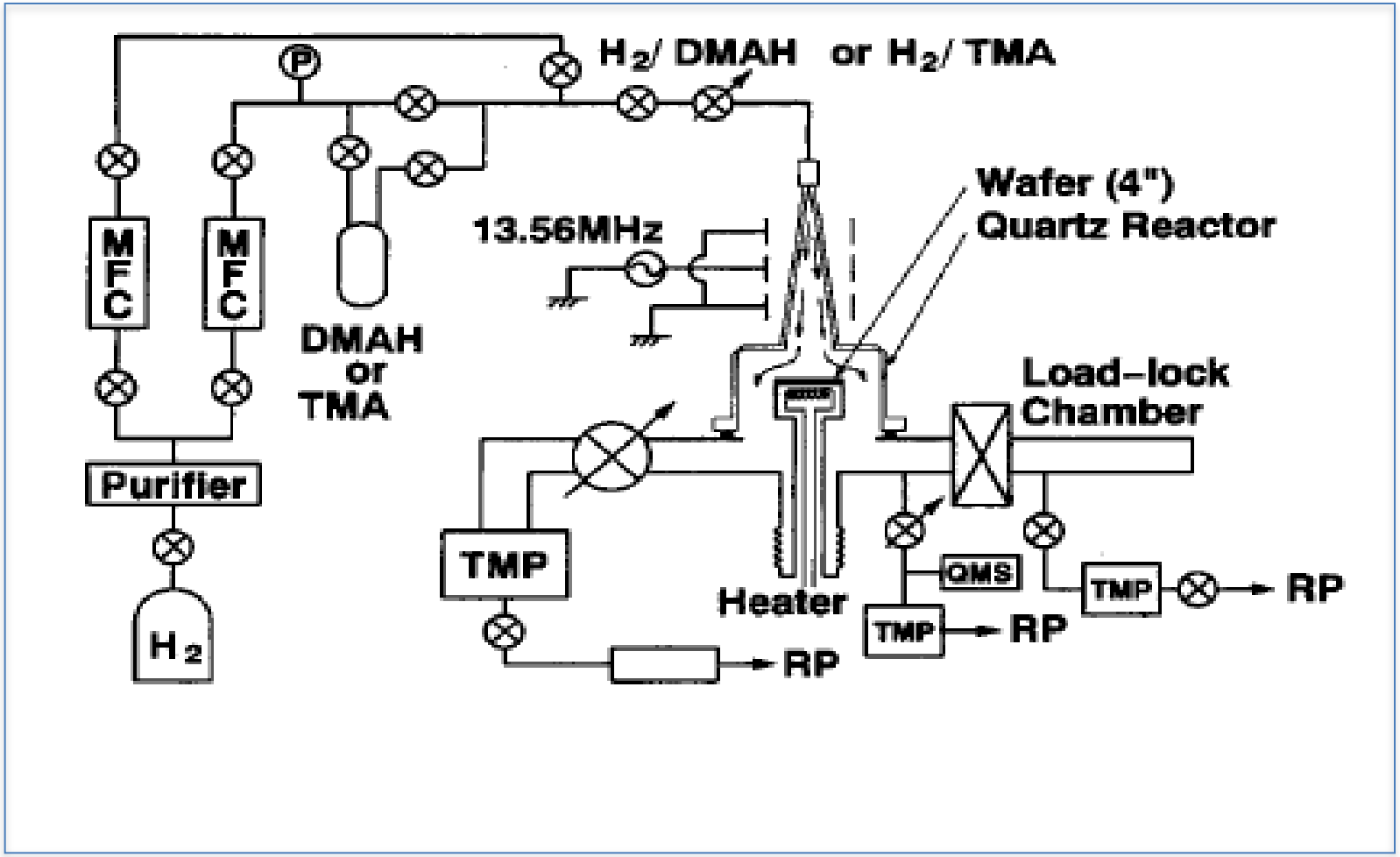
This work could enable a joint space mission serving two communities, ultraviolet astronomy and exoplanet direct imaging.

A direct-imaging exoplanet mission was recommended by the Astrophysics Decadal Survey in 2010 as the highest-priority technical development area for the current decade, with the goal of flying a major mission in the 2020s.

In early 2011, NASA's Exoplanet Program Analysis Group (ExoPAG) and Cosmic Origins Analysis Group (COPAG) agreed to investigate a joint mission, using a common 4-8-m telescope with separate focal planes.

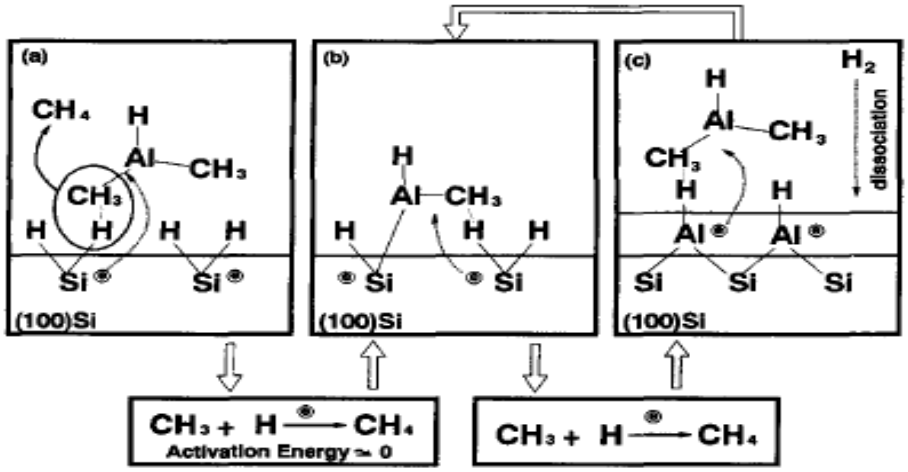
Current state of the art: No existing coating will simultaneously give high reflectance over the 0.1 to 1.0 micron spectral range and also give small polarization phase shifts in the visible. The goal of this project is to start toward developing such a coating, using the technique of ALD.

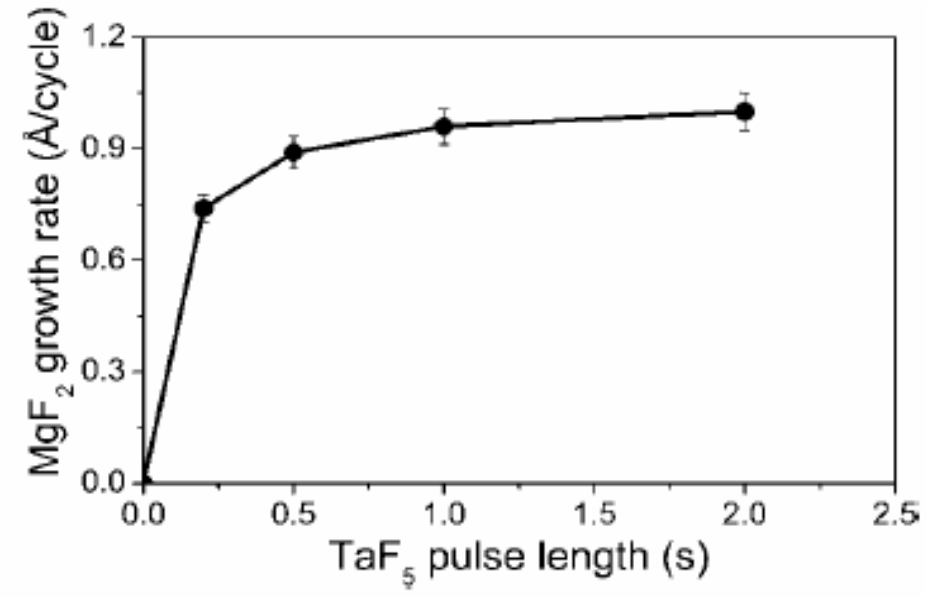
Atomic Layer Deposition



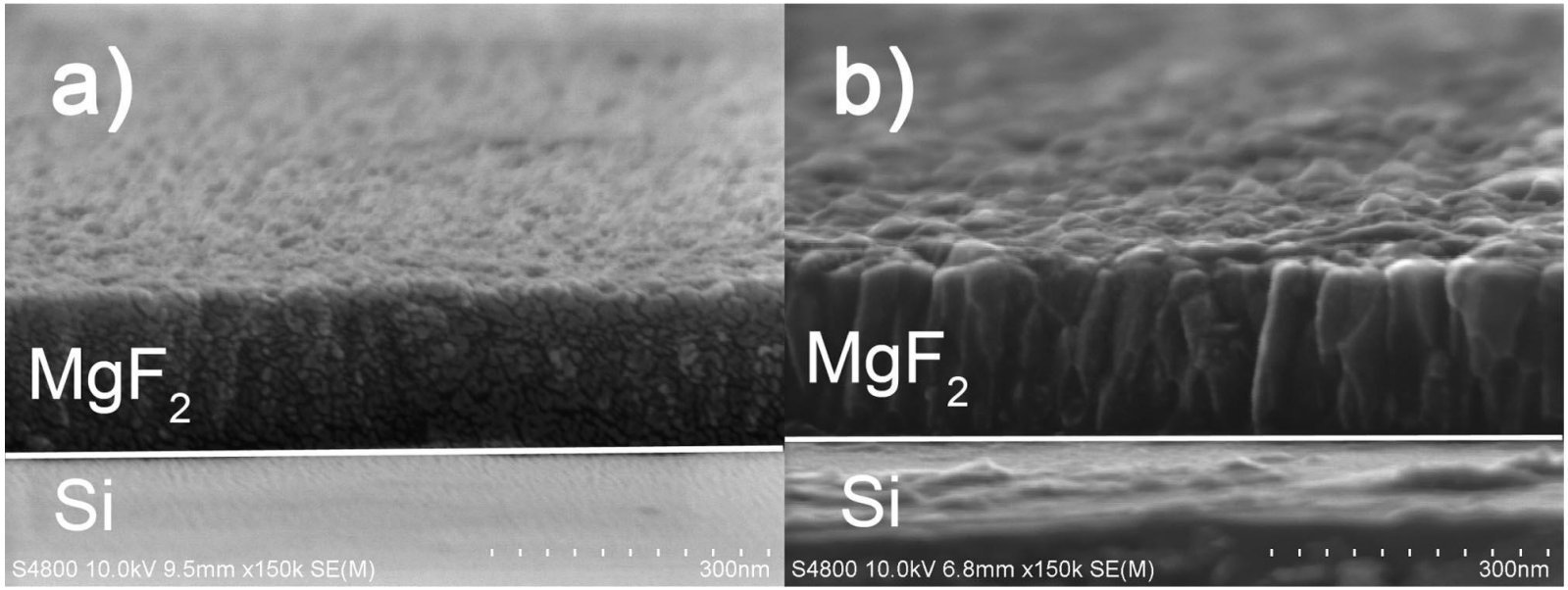
Ref.: Tsubouchi & Masu, Vacuum 46, 1995

ALD steps

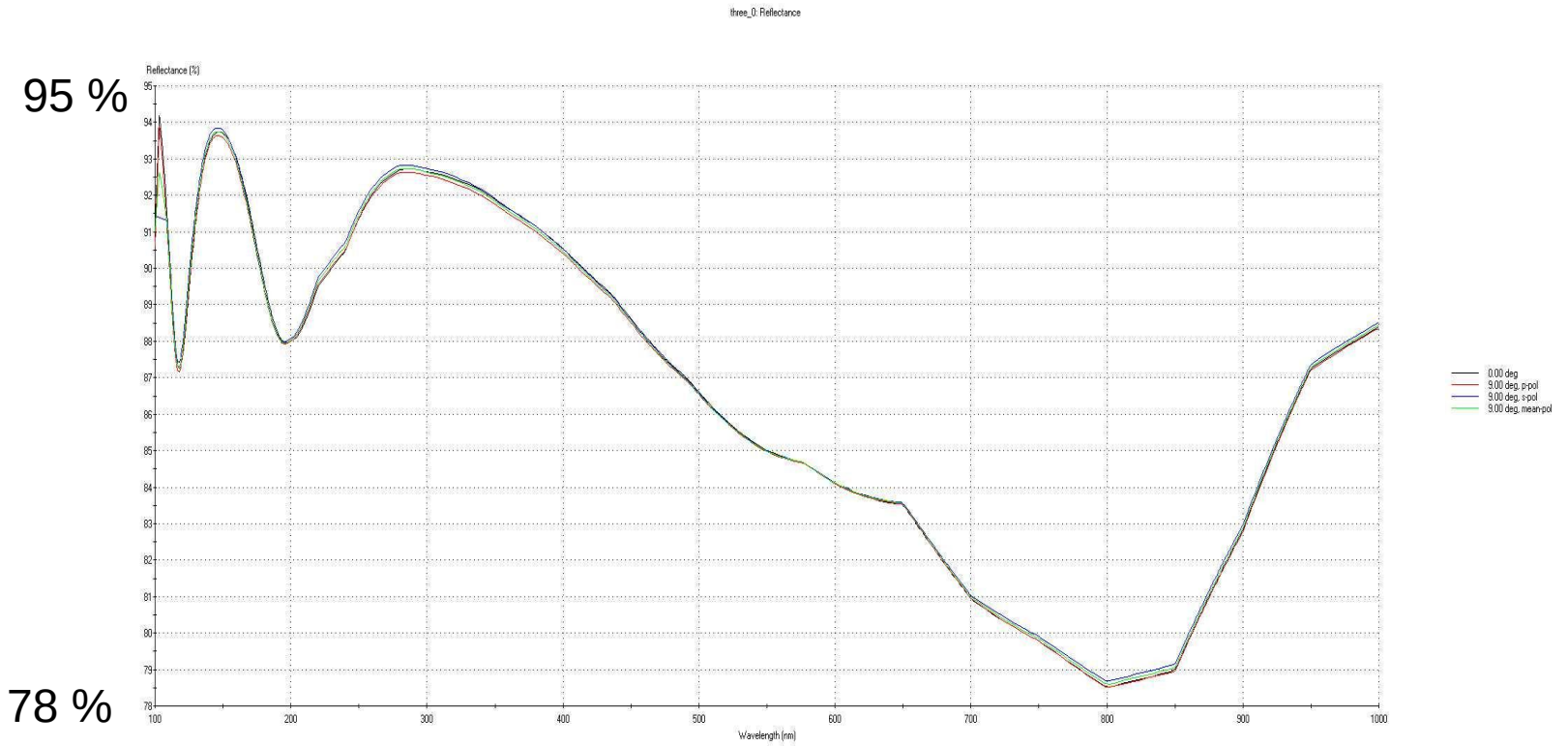

(a)
(b)
(c)
CH_4
H
Al
CH_3
H_2
dissociation
Si
(100)Si
$CH_3 + H \rightarrow CH_4$
Activation Energy ≃ 0


MgF_2 growth rate (Å/cycle)
1.2
0.9
0.6
0.3
0.0
0.0
0.5
1.0
1.5
2.0
2.5
TaF_5 pulse length (s)

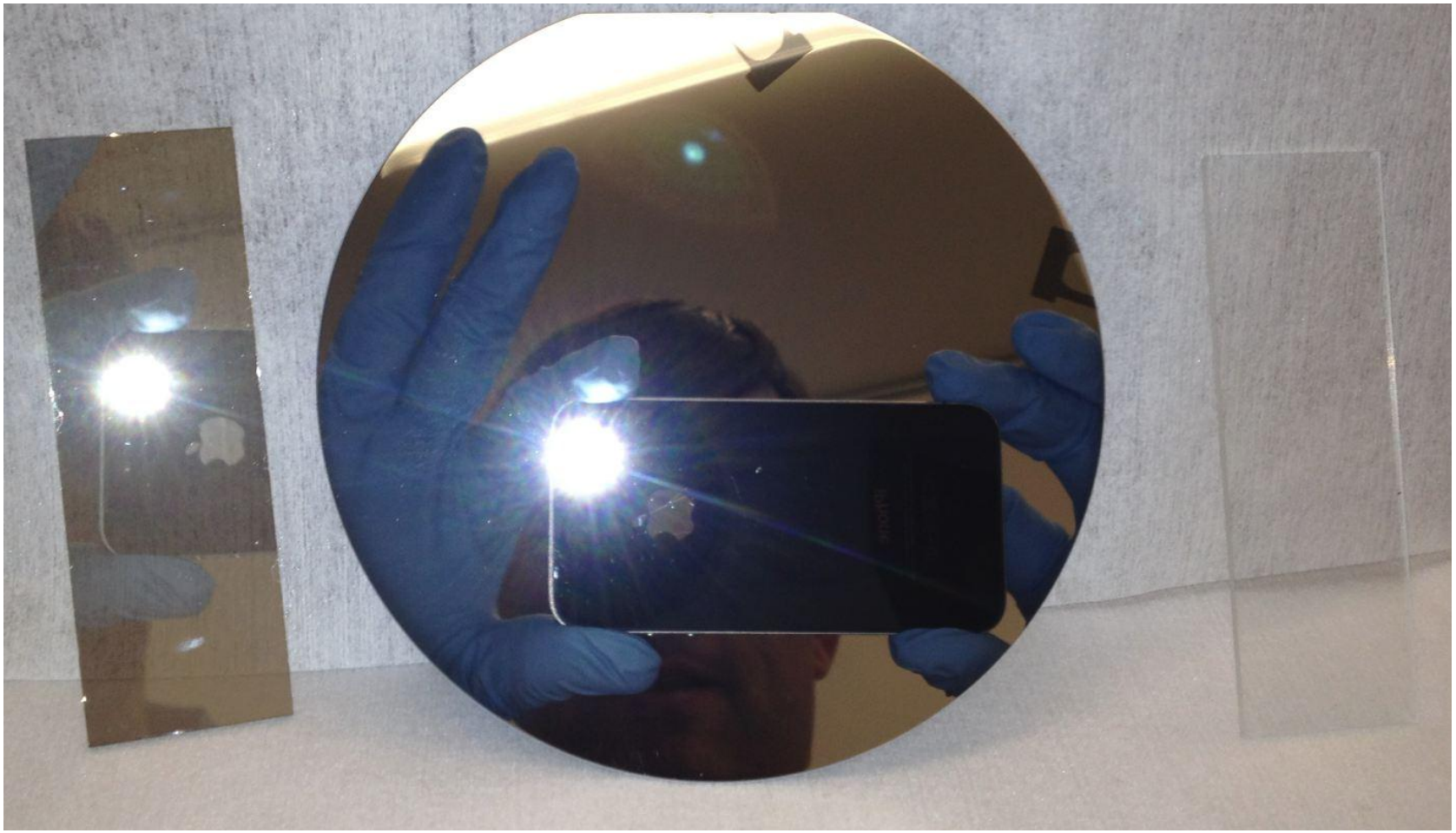
MgF_2 films on Si



Calculated reflectance of MgF_2 on Aluminum



Reflectivity of Ultrathin Aluminum



Ultrathin (partially transparent) ALD Aluminum on Glass

E-Beam Evaporated Aluminum

Blank Glass Slide