

*Annual Symposium of
Taiwan Association for
Coating and Thin
Technology*



Advanced coating process for optical thin film
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Outline

- *Optical thin film and its coating process*
 - *Optical thickness termination*
 - *Micro-structure dependence of optical thin film*
- *Some new advanced techniques on optical thin film coaters*
- *Conclusions*

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➤CVD (Chemical Vapor Deposition)

- *Thermal CVD*

- *PECVD(Plasma Enhanced CVD)*

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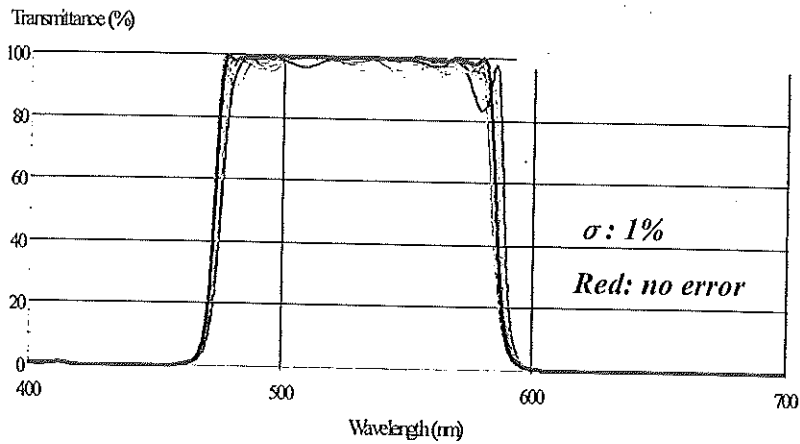
Present status of conventional coater for optical thin film

Requirements	Status	Strategy
Bulk-like, homogenous thin film	Unstable refractive index	Optical monitor for optical thickness and
Thinner layer	$d > 50\text{nm}$	
Adjustable intermediate n	Poor repeatability	
Good yield and low cost	Strong operator dependence	

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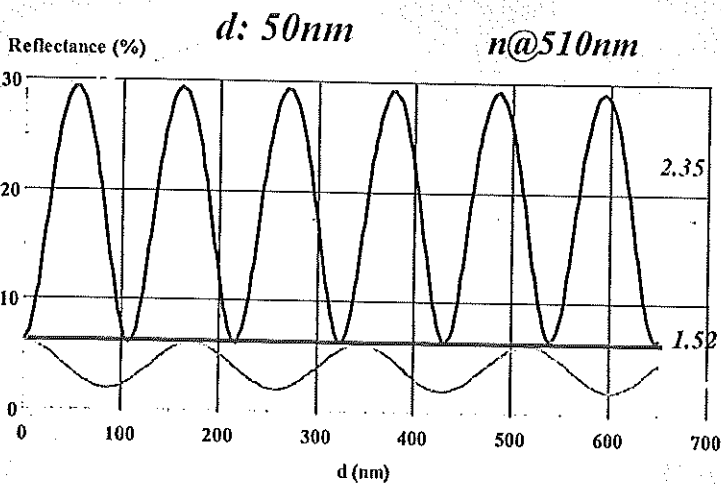
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Thickness error dependence of 40 Layer green filters



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Refractive index dependence of single layer reflectance

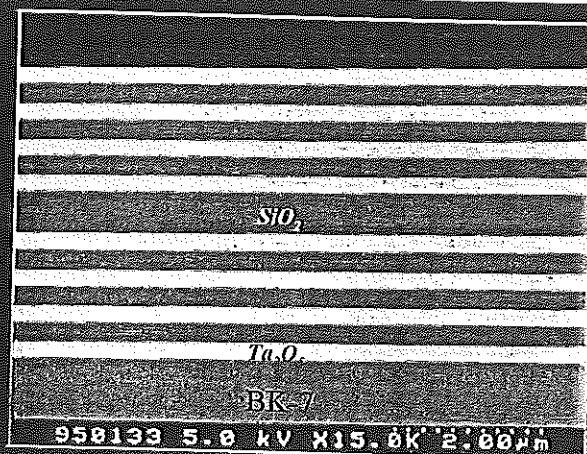
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Optical properties and microstructures of dielectric thin films

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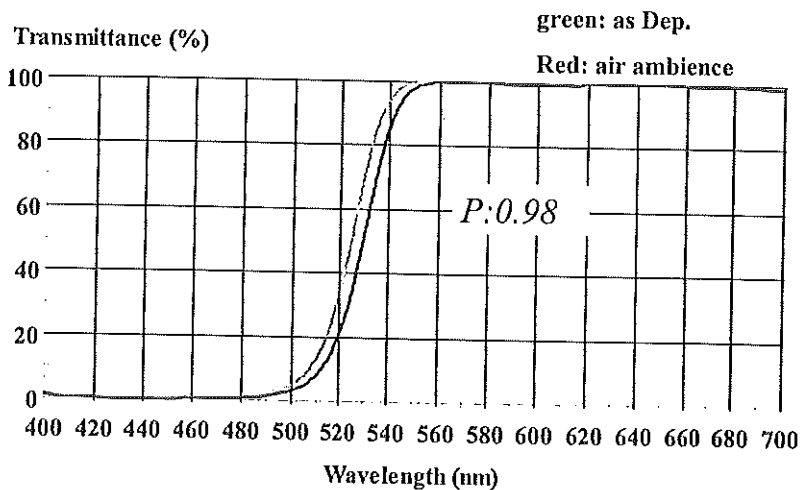
***Cross-sectional SEM micrograph of IAD Ta_2O_5/SiO_2
multilayered filter***

Ion source: E: 750eV, O_2 : 2.0×10^{-2} Pa,

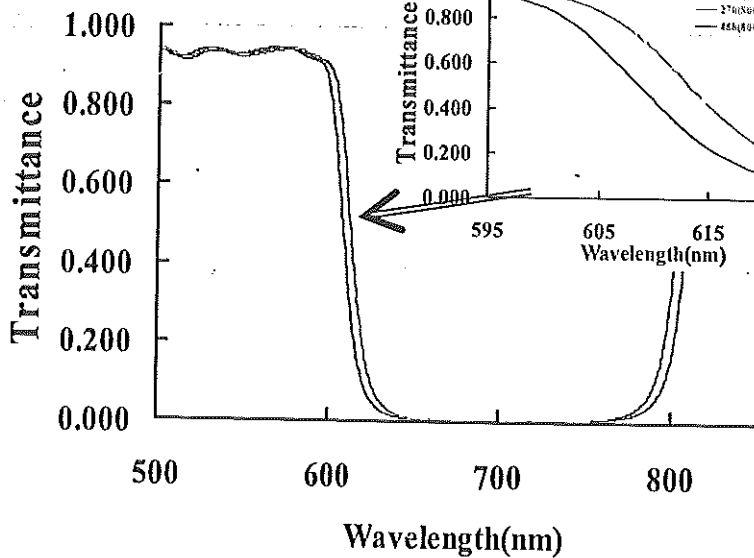
Arrival ratio: 0.2(Ta_2O_5), 2.0(SiO_2), Ts: 300C,

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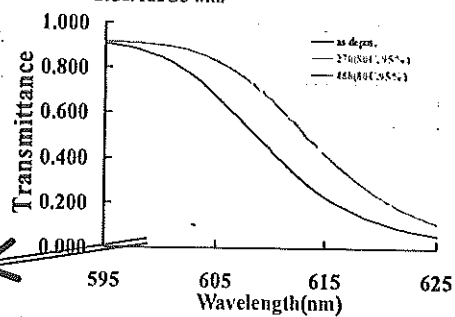
Wavelength shift of 17 layers LWPF

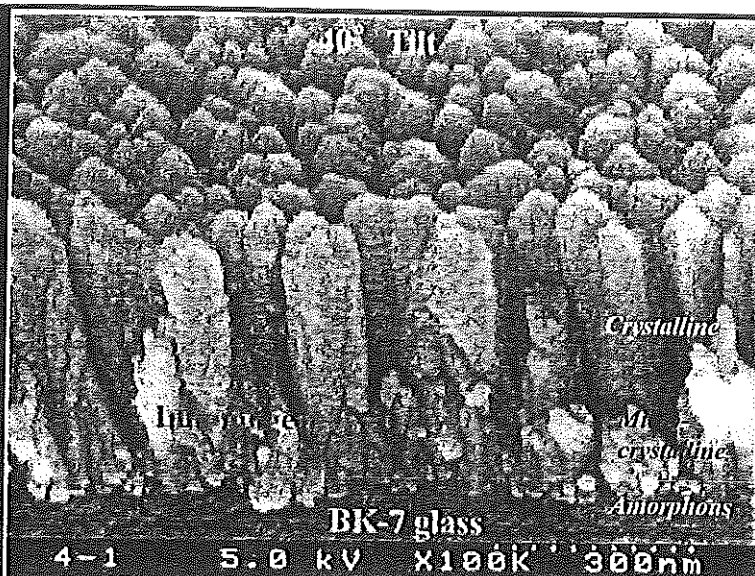


Stability of edge fi SiO₂/Ta₂O₅ with

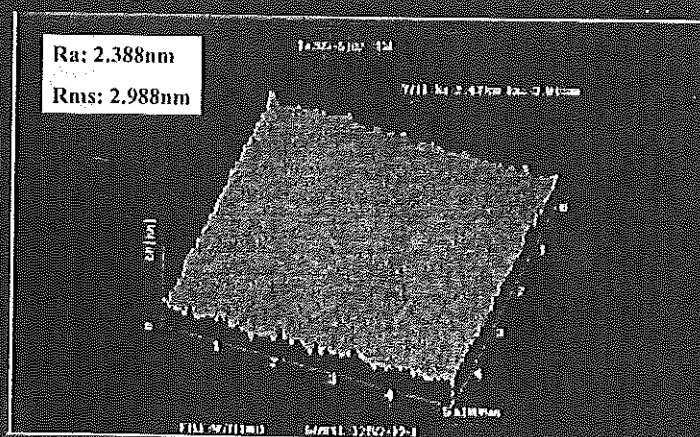


Stability of dichroics filter stacked by RAS SiO₂/Ta₂O₅ with





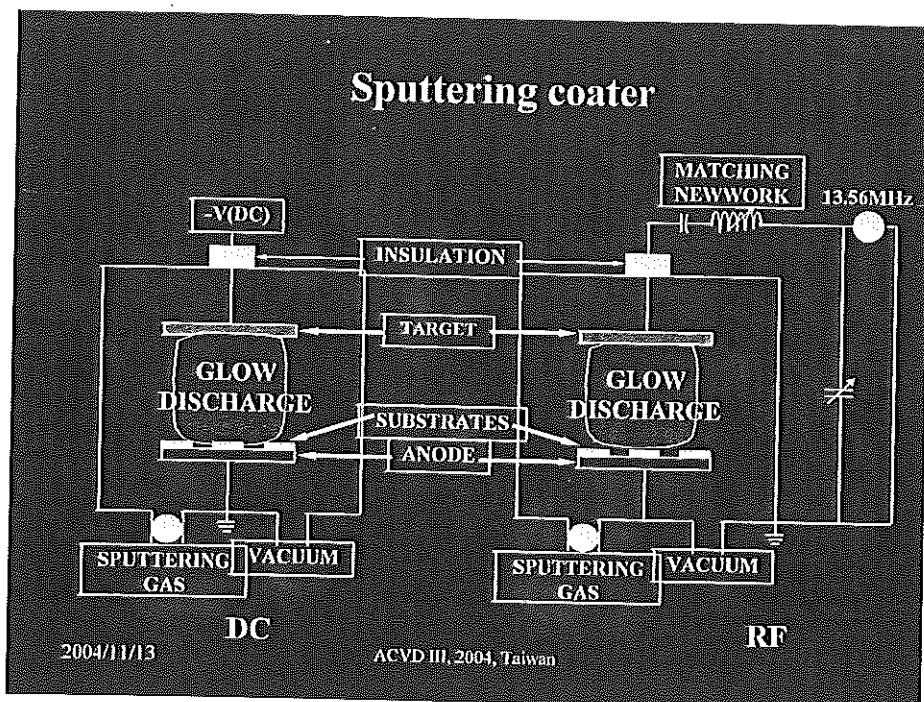
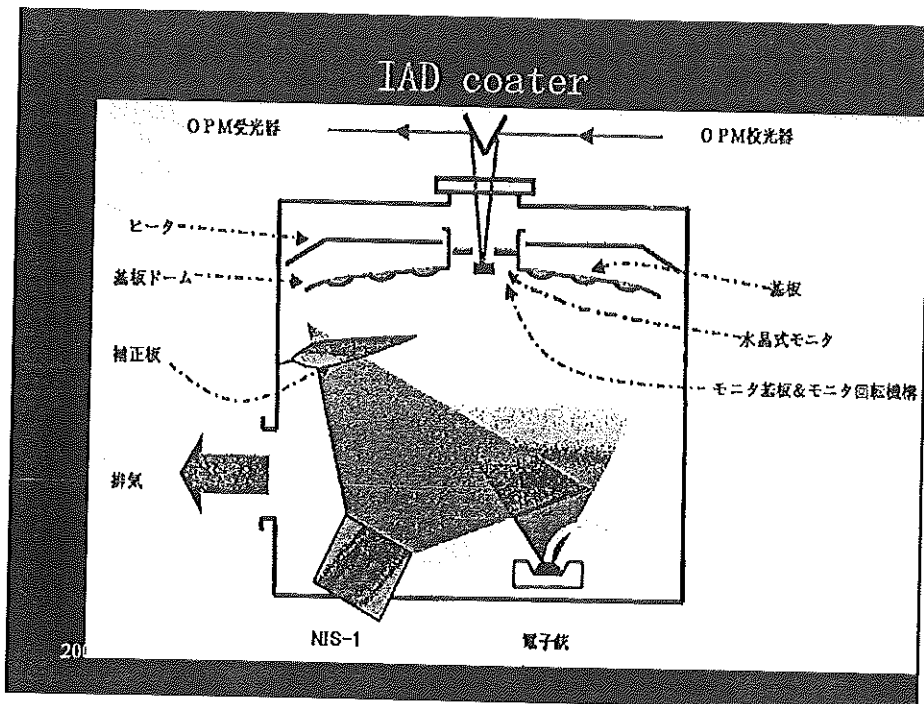
Surface-view and cross-sectional SEM micrograph of ZrO_2 with columnar and inhomogeneous microstructures



AFM of IAD Ta_2O_5/SiO_2 multilayered filter

Ion source: E : 500eV, O_2 : 4.6×10^{-2} Pa,

Arrival ratio: 0.4(Ta_2O_5), 2.5(SiO_2), T_s : 300C,



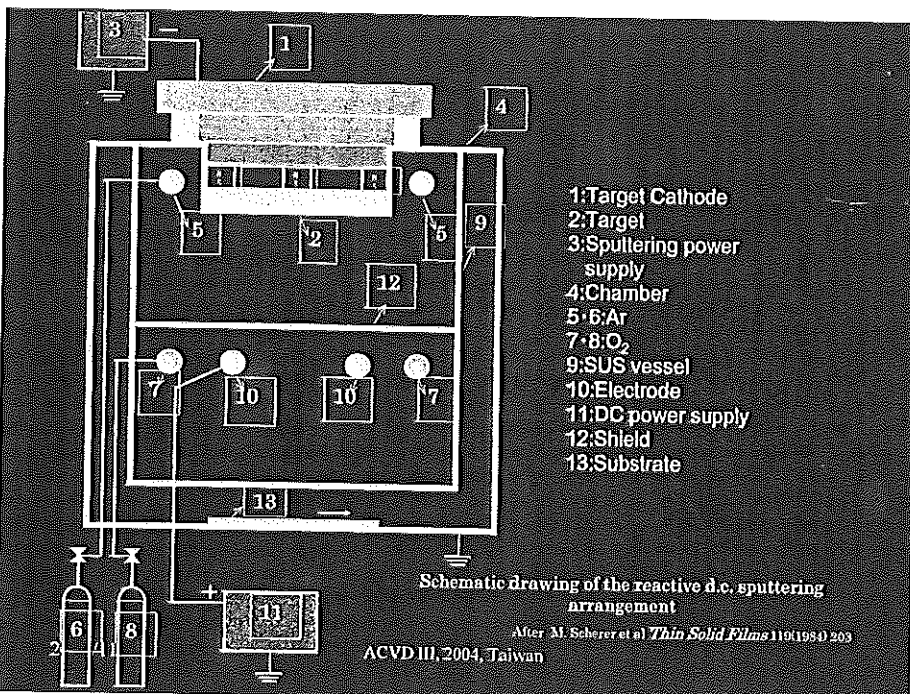
High rate sputtering systems(I)

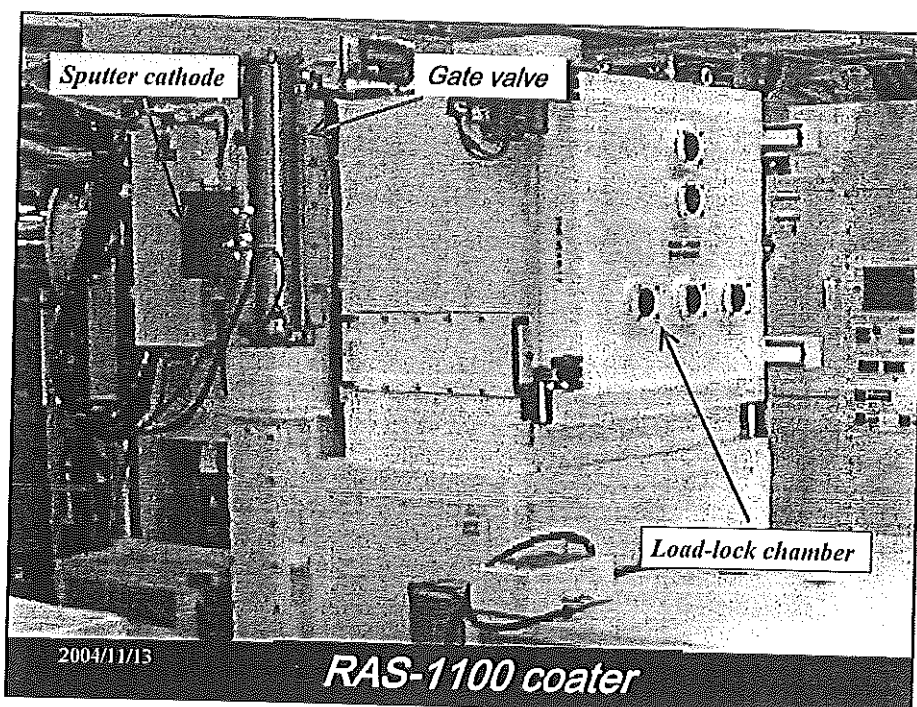
Separated oxidation area from the
Sputtering area

Scherer: Leybold, 1984
TSH: Shincron
Meta Mode: OCLI

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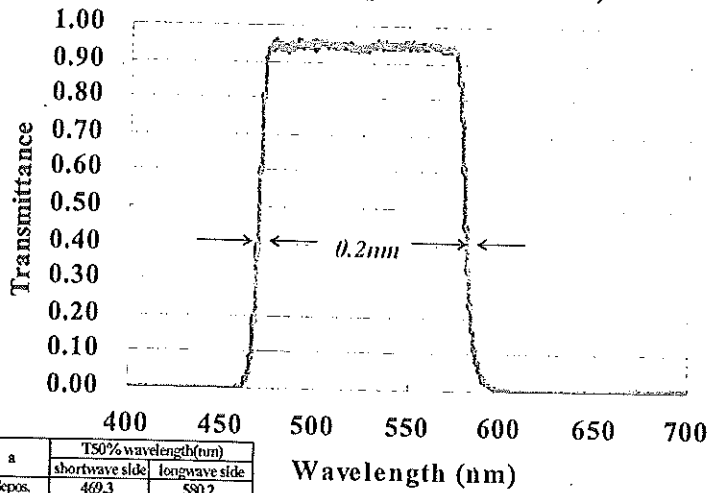




Characteristics of RAS (1)

- **High rate, low temperature and arcing-free sputtering coater to deposit high quality thin film w/o wavelength shift and absorption**

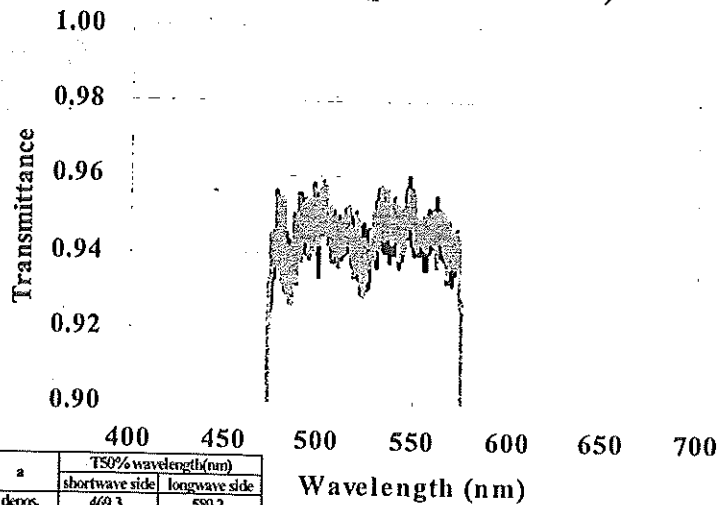
Boiling test of 40 layer green filter stacke by
RAS Nb₂O₅/ SiO₂(pure water 1 hour)



200

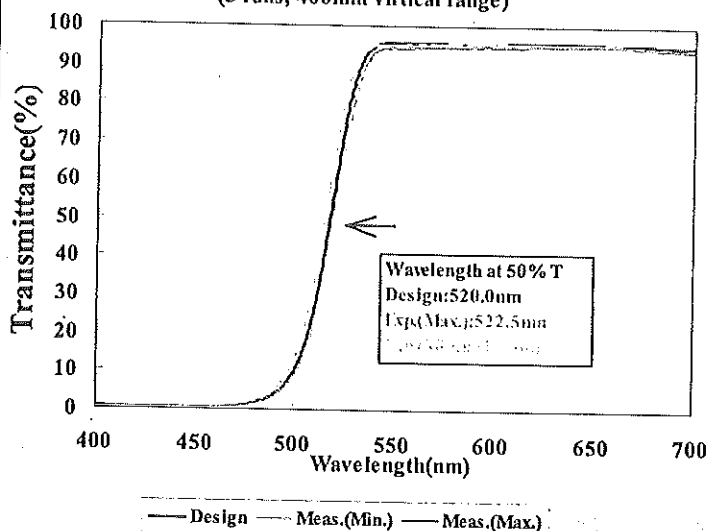
— as depos. — after boiling

Boiling test of 40 layer green filter stacke by
RAS Nb₂O₅/ SiO₂(pure water 1 hour)



— as depos. — after boiling

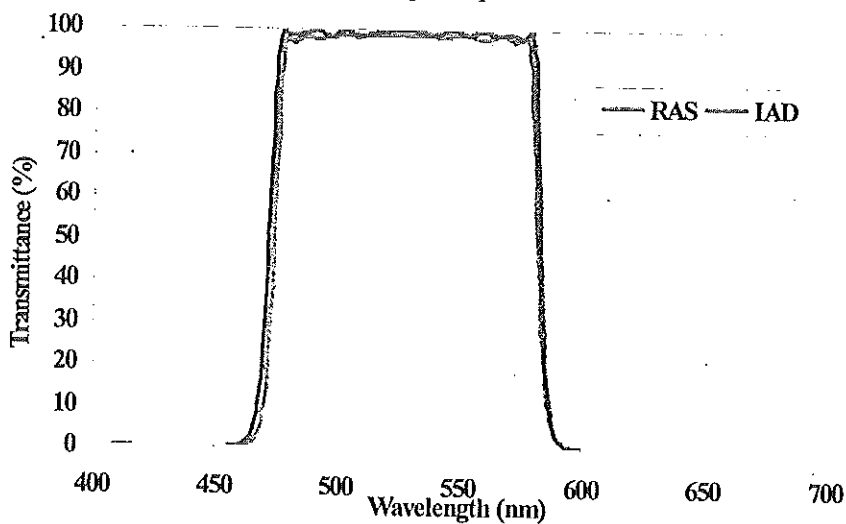
Spectral performance repeatability of RAS-1100
17 layer LWPF stacked by Nb2O5/SiO2
(5 runs, 400nm virtual range)



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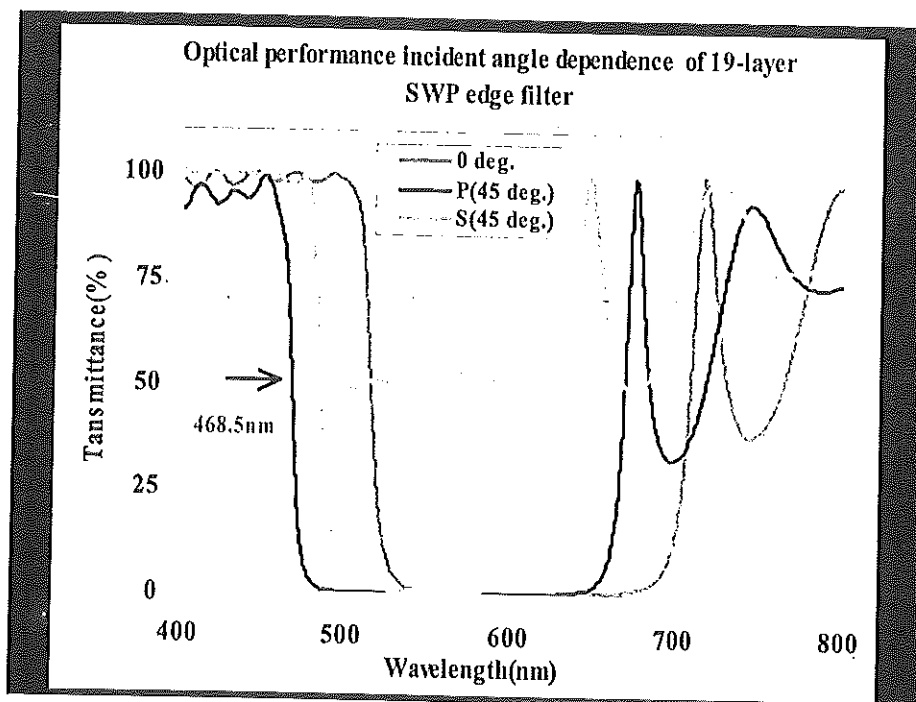
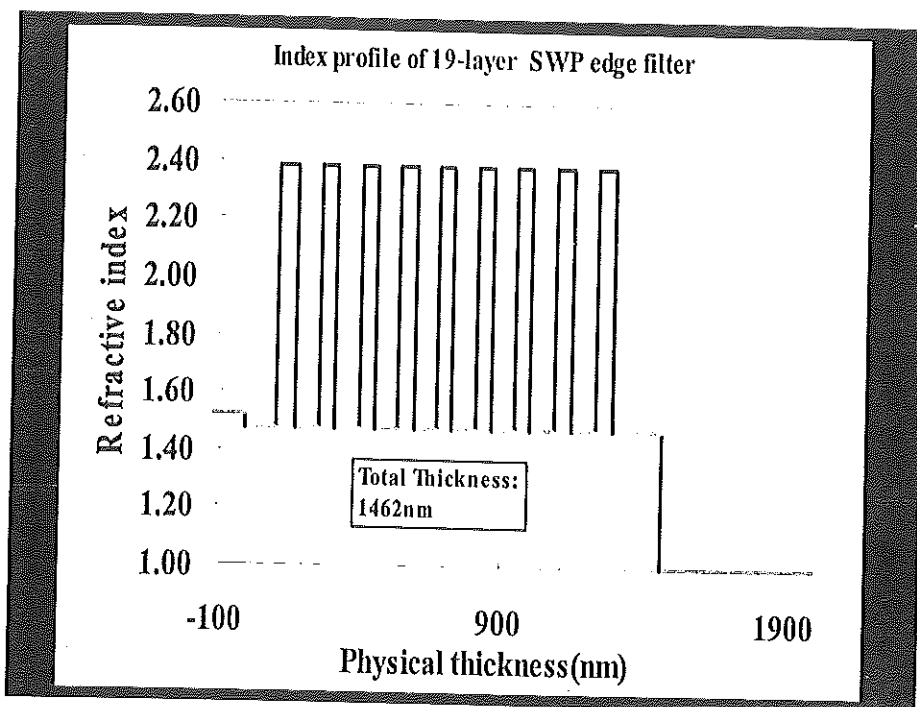
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Green dichroic filter design comparison of RAS and IAD



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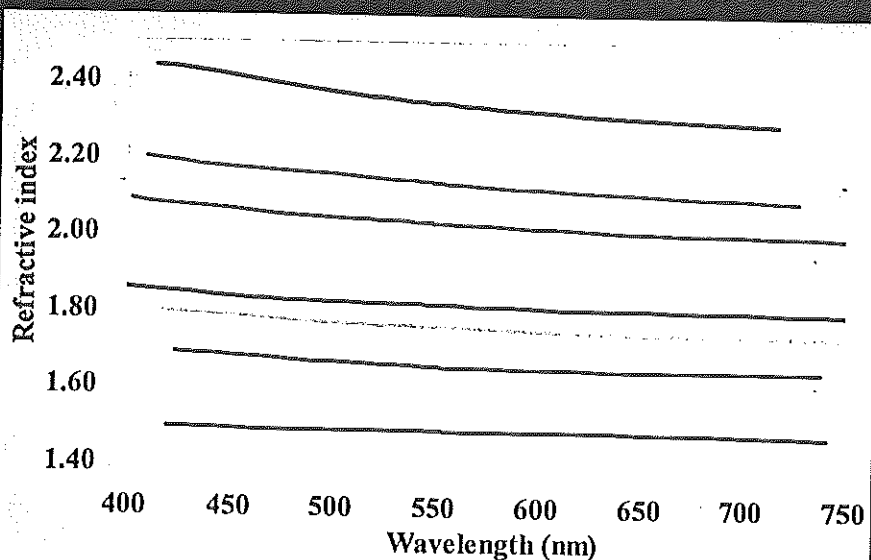
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Deposition conditions of intermediate index films

	Film	Nb Power (kW)	Si Power(kW)	RFS power (kW)	Refractive index @550nm	Deposition rate (nm/s)
①	Nb2O5 (2.34)	5.00	0.00	4.0	2.34	0.395
②	Nb2O5/SiO2 (2.15)	6.00	2.45	5.0	2.15	0.628
③	Nb2O5/SiO2 (1.76)	2.50	8.00	5.0	1.76	0.534
④	Nb2O5/SiO2 (1.65)	1.80	8.00	5.0	1.65	0.509
⑤	SiO2 (1.47)	0.00	8.00	4.0	1.47	0.347

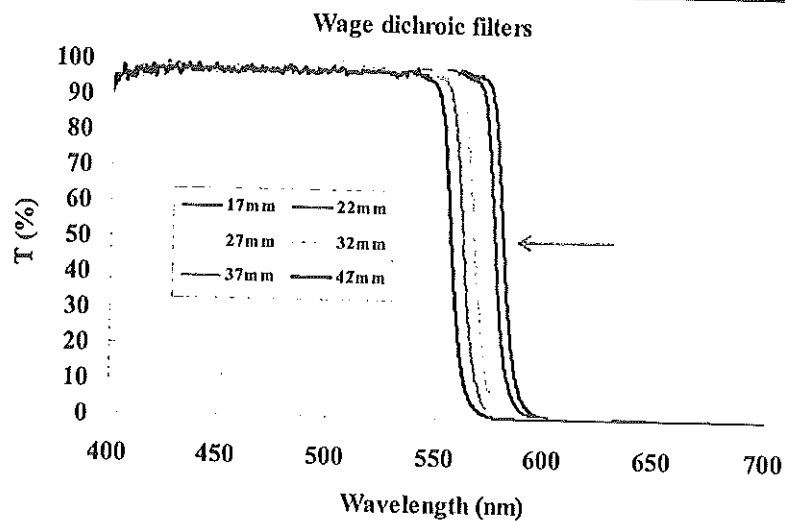
Dispersions of the RAS intermediate index films



Application of RAS coater

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Distance(mm)	17	22	27	32	37	42
M @50%T(nm)	580.6	576.6	571.4	567	562	556.6
FWHM(nm)	4	5.2	4.4	5	5.4	0
Average(nm/mm)	0.96					

The Future of Optical Coatings

Angus Macleod

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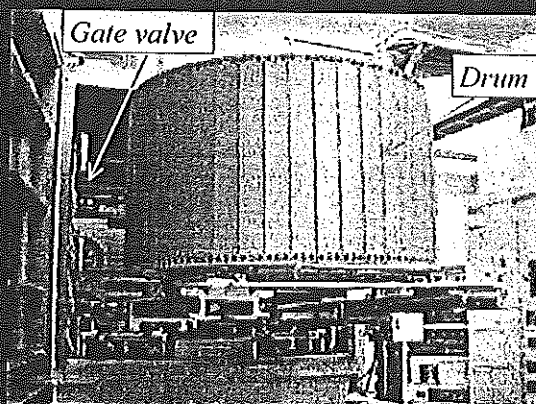
Courtesy thin film center Inc, Tucson USA

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*ACVD III, 2004, Taiwan
Optical Interference Coatings 2004, Tucson USA June 28 2004*

Radical-Assisted Sputtering (RAS)

In Radical Assisted Sputtering the film treatment is by electrically neutral activated species. Any charged particles are removed from the reactive gas before it reaches the film. High quality optical coatings can be produced in half the time of more conventional processes



Courtesy Shineron Co Ltd, Tokyo

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