Improved IR Blocking and Durability for Ultrathin Aluminum/Polyimide Filters

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Infrared blocking with high EUV transmission is needed for instrument elements such as thermal shields, contamination blocking filters, and micro-calorimeter windows. Large differences in infrared transmission were observed for aluminum/polyimide bilayers, even when thickness and visible transmission were nearly identical.

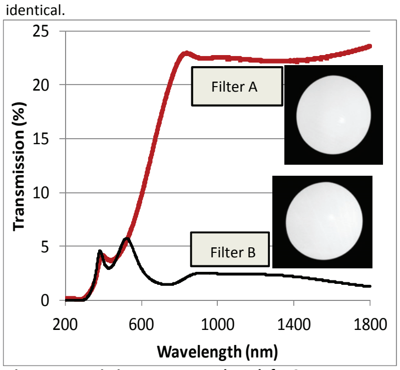


Fig. 1: Transmission versus wavelength for 25nm Al/200nm polyimide for Process A and Process B. Inset: Visible transmitted light image.

Aluminum deposition experiments tested the effect of precleans, deposition rate, substrate choice, post-treatments, etc. The most significant factor for infrared blocking was found to be having the polyimide in thermal contact with a substrate during coating.

Process Variable Infrared Optical Density Response

Conditon:	Response (T 1800nm)
Off vs wafer System 6 Ebeam Evap	-1.17
Off vs On Wafer Thermal Evap	-0.92
Off vs On Wafer System 5 Ebeam Evap	-0.89
High Dose Air Plasma	-0.08
Low Dose Air Plasma	-0.03
Low Dose ArH plasma	0.02
Ion Beam Clean	0.03
System 6 vs System 5	0.04
High Dose ArH plasma	0.05
Front vs back side coating	0.05

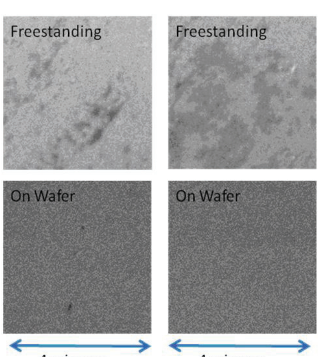


Fig. 2: SEM images showed the films deposited on freestanding polyimide were discontinuous.

A Lorentz oscillator model was developed assuming superposition of discontinuous aluminum layers [1]:

Islands

$$\varepsilon(\omega)=\varepsilon_b+\frac{\omega_{p1}^2}{\omega_1^2-\omega(\omega+i\gamma_l)}$$

Holes (=continuous film+ "-islands")

$$\varepsilon(\omega)=\varepsilon_b-\frac{\omega_{p0}^2}{\omega(\omega+i\gamma_l)}+\frac{\omega_{p2}^2}{\omega_2^2-\omega(\omega+i\gamma_l)}$$

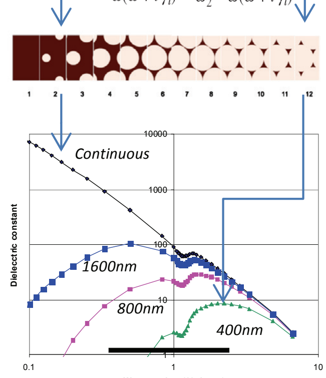
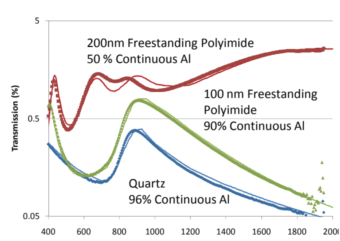


Fig. 3: Model for dielectric response of continuous and islanded aluminum.



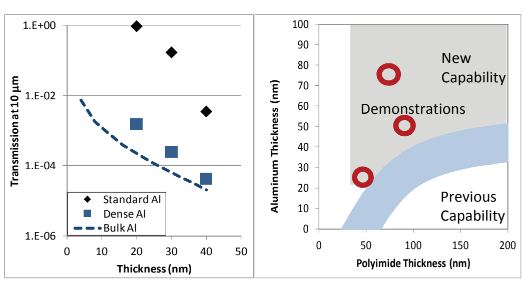
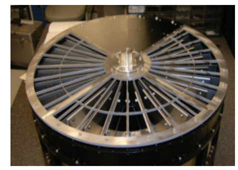


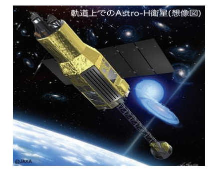
Fig. 4: Fits to 25nm aluminum with new process has near-bulk IR blocking

Applications

Thermal Shields

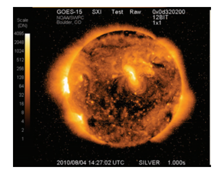


Microcalorimeters

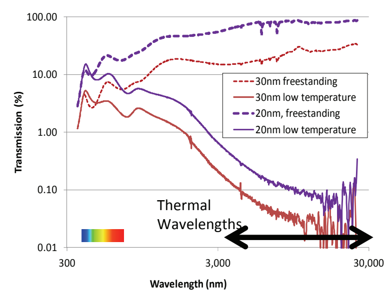


Contamination Blocking

EUV Filters



Results



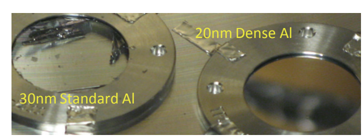


Fig. 5: 20nm and 30nm Al with the new process provide far higher IR blocking and atomic oxygen resistance

Aluminum on polyimide using the new low-temperature process results in 1,000x better IR blocking and improved atomic oxygen resistance. The new process produces aluminum with near-bulk optical properties bulk at thicknesses as low as 20nm.

REFERENCES

[1] Y. Peng, T. Paudel, W.-C. Chen, W.Padilla, Z. Ren, and K. Kempa, "Percolation and polaritonic effects in periodic planar nanostructures evolving from holes to islands" APL (2010).