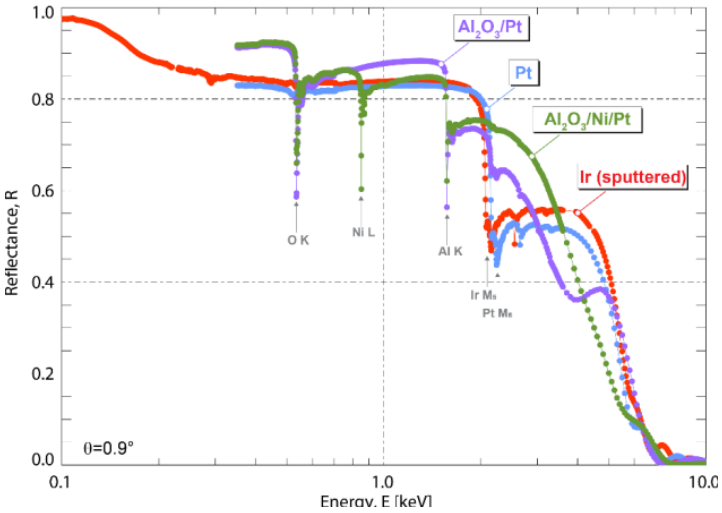
ARRADIANCE ***Sneak Preview***

X-ray reflective coatings made of Pt, Ni, Al_2O_3 produced by ALD

October 23, 2024

Mitigation of stress-driven substrate deformation remains a high priority active area of research for X-ray astronomy. X-ray telescope mirrors require high reflectance optical coatings to maximize their ability to collect data efficiently. While dense and smooth surface single-layer magnetron sputtering coatings of Ir and Pt provide the needed high reflectance at soft X-ray energies, the high film stresses yield deformations of these precision mirrors. Multilayer coatings of bilayer and trilayer materials on the thin segmented mirror substrates reduce these stresses, however, even this does not succeed with achieving the desired sub-arcsecond angular resolution for the mirrors to be successful for future X-ray astronomy missions. Another solution is needed.

Pt and Ir coatings have been successfully deposited using Atomic Layer Deposition (ALD), particularly on complex optical surfaces in high-aspect ratio X-ray structures, such as Micro-Pore Optics and Critical-Angle Transmission (CAT) gratings. ALD conformally coats all exposed surfaces and deposits coatings onto both the front and back of thin segmented mirror substrates, effectively balancing and canceling out film stress. In this Arradiance collaboration[1], X-ray optics scientists measured the grazing-incidence X-ray reflectance of several coatings: single-layer Pt, Al_2O_3/Pt bilayer, and Al_2O_3/Ni/Pt trilayer coatings, all grown at Arradiance using ALD (Al_2O_3, Pt) and PEALD (Ni) on flat Si wafers. These coatings were tested with synchrotron radiation at X-ray energies range from 0.35 to 10 keV. The results show high X-ray reflectance matching modeled results, and comparable to, or outperforming sputtered Ir at certain energy bands below ~3.5 keV. Additionally, an ALD-coated batch of two polished, single crystal silicon mirrors illustrates the potential of stress-balanced, double-sided thermal Al_2O_3/Pt ALD coatings to mitigate stress-driven mirror deformation. Notably, re-measurements of the curvature of mirrors coated with Al_2O_3/Pt after 18 months of storage in air or dry nitrogen showed no changes in mirror curvature over time. Thermal ALD is a feasible approach for the development of sub-arcsecond grazing-incidence X-ray telescopes.



Arradiance provides cutting-edge ALD solutions for thin-film semiconductor, solar, scientific and green energy applications. For more information on GEMStar™ Technology, ALD systems or Foundry services, please contact Arradiance.

1. David L. Windt, Huazhi Li, Dmitry Gorelikov, Eric M. Gullikson, Christian Gollwitzer, Michael Krumrey, and Christian Laubis, "**X-ray reflective coatings made of Pt, Al_2O_3/Pt, and Al_2O_3/Ni/Pt produced by atomic layer deposition**", **Applied Optics** Vol. 63, p. 6532 (2024) https://doi.org/10.1364/AO.535173