Vacuum Process Technology LLC

thinnovation

Plasma Assisted Pulsed DC Magnetron Sputtering System for Optical Thin Film Coatings

Keqi Zhang and Ralph Faber

Vacuum Process Technology LLC

2013 OSA Optical Interference Coatings

Whistler, British Columbia, Canada

June 2013

Abstract

Using plasma assisted pulsed DC magnetron sputtering technology, low loss, high performance optical coatings have been achieved. Multi-layer coating examples using Ta_2O_5 and SiO_2 materials are demonstrated. This technology is suitable for volume production.

Motivation

Offer a deposition tool for optical coating industry that combines the advantages of both

- E-beam evaporation (large area, fast rate)
- IBS deposition (stable process, superior film quality).

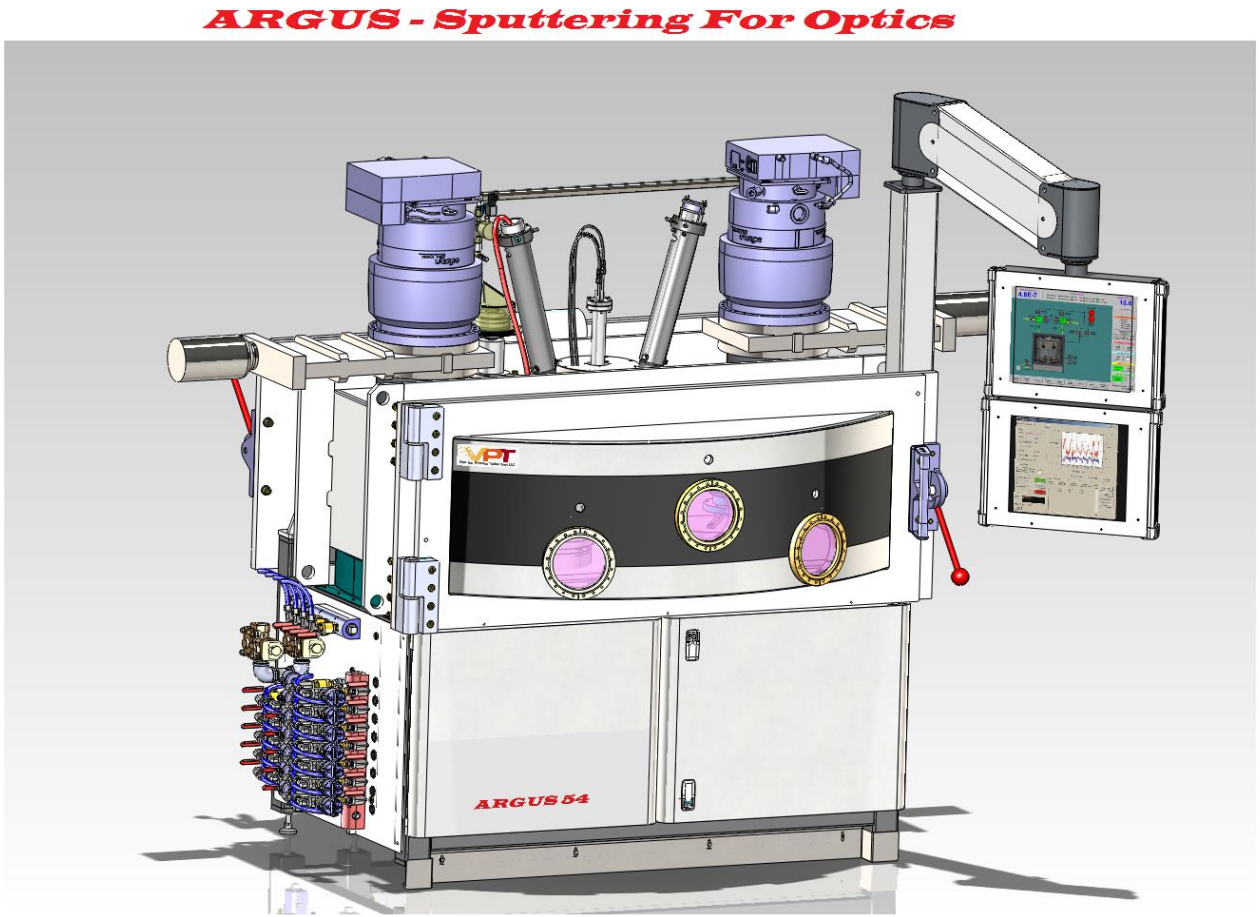
Approach

- Plasma Assisted Pulsed DC Magnetron Sputtering
- Real-time feedback control of O_2 flow to further improve process stability
- Film thickness controlled by time–power
- Planetary system with up to six 400mm planets

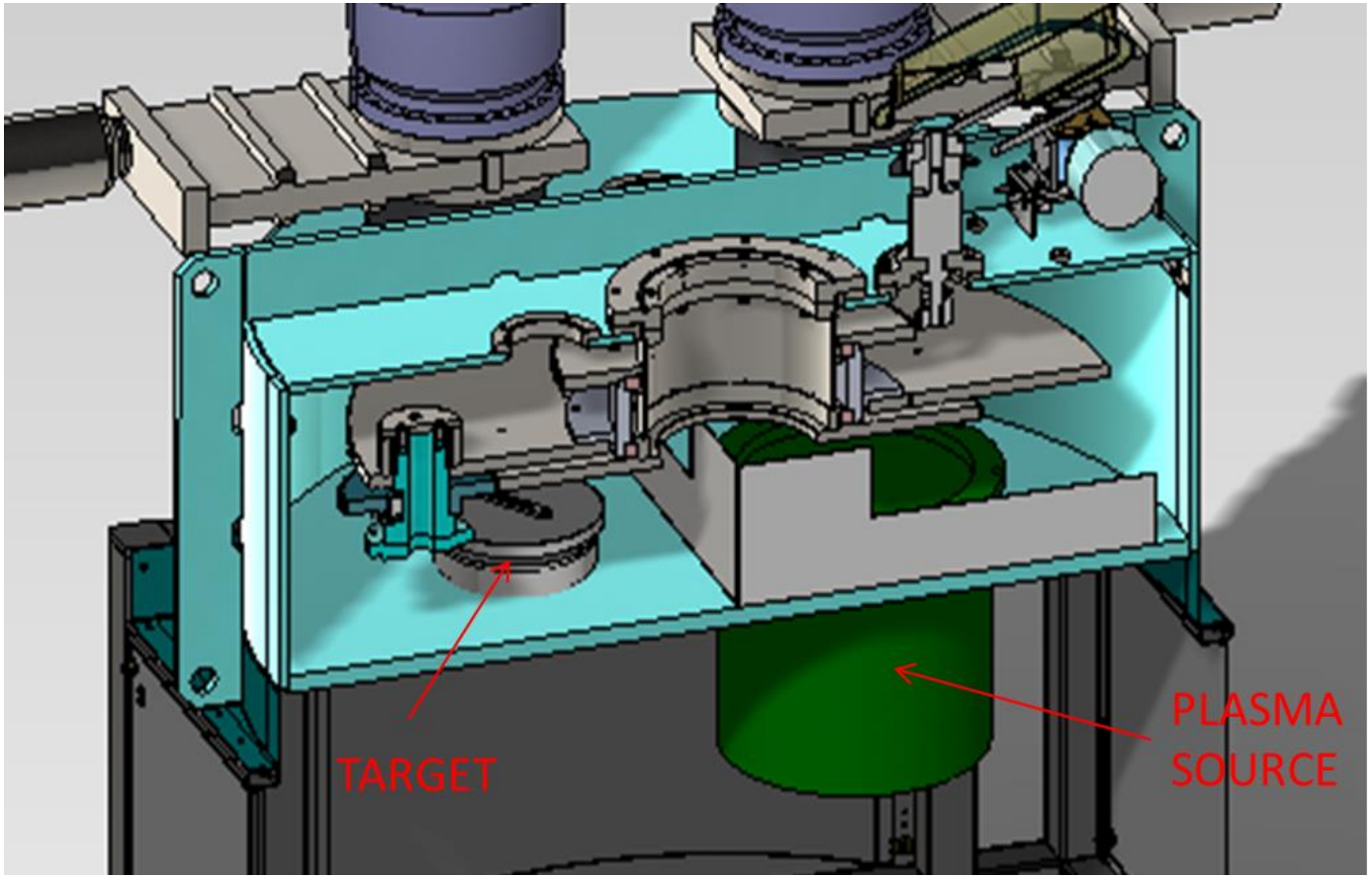
Experiments

- Ta and Si targets were installed and efficiently sputtered to form Ta_2O_5 and SiO_2 thin films
- Characterized Ta_2O_5 and SiO_2 film properties:
  - n & k
  - Stress
  - Uniformity
- Coating examples

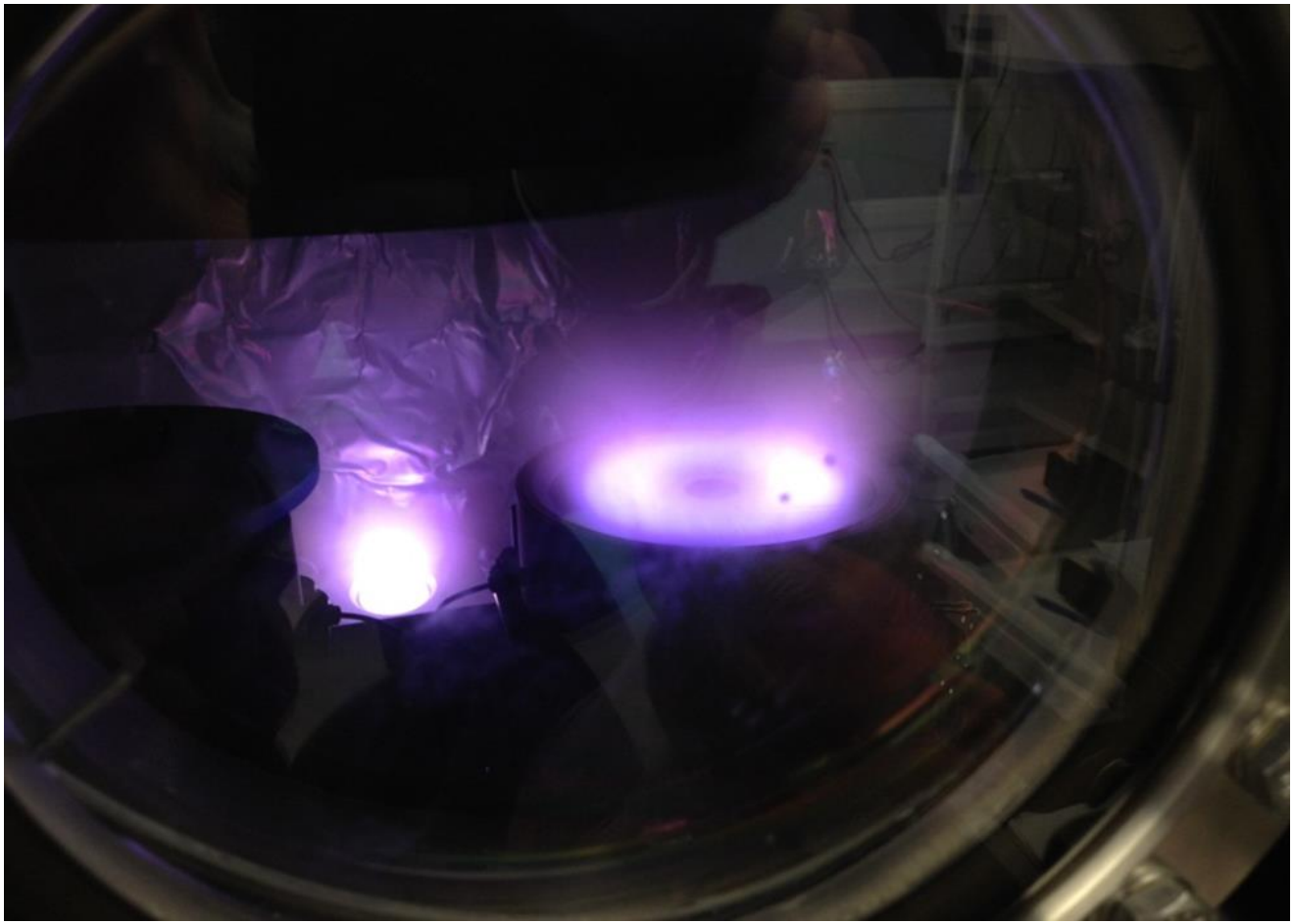
Optical Sputter Coater



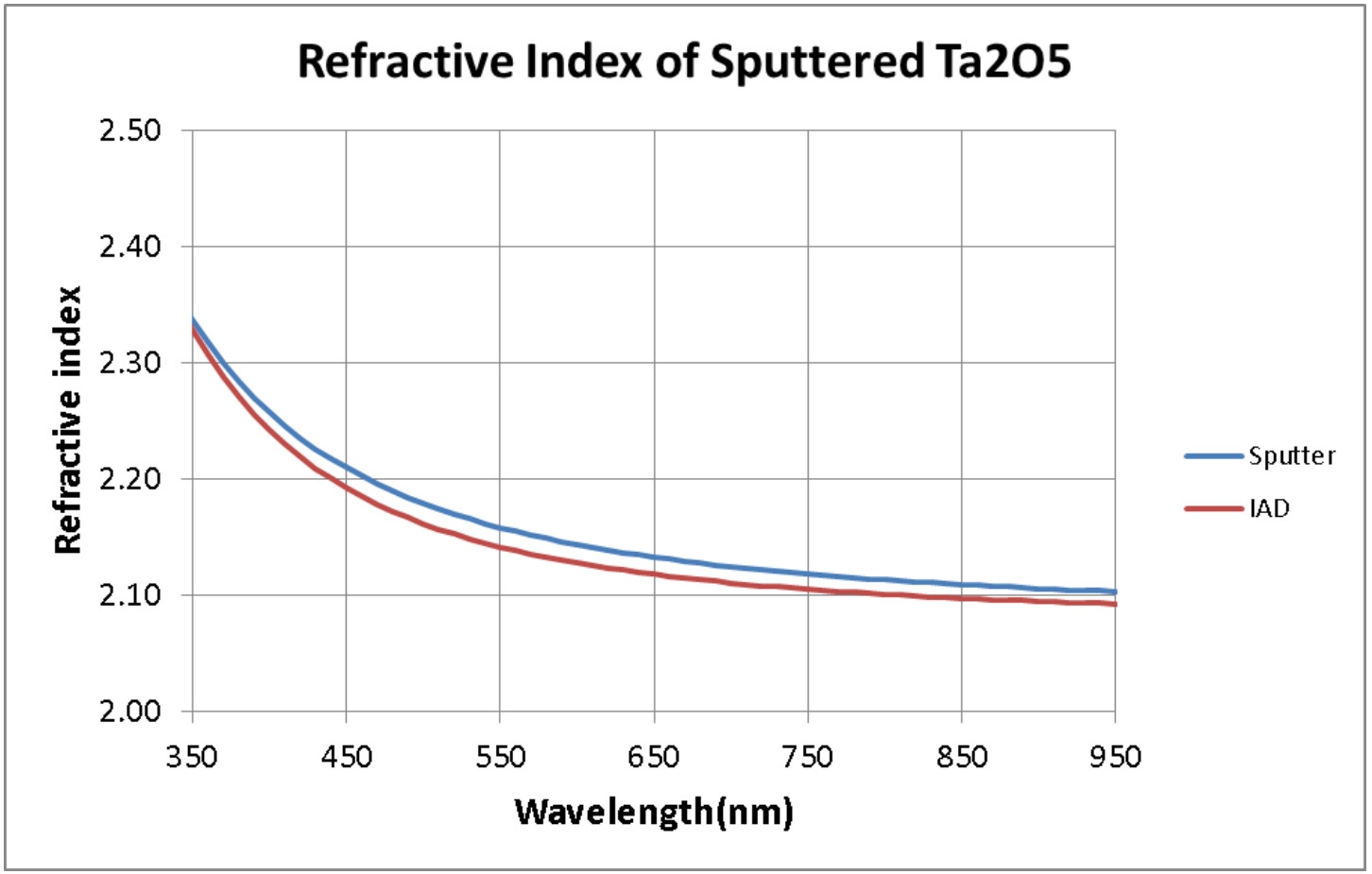
Optical Sputter Coater Overview



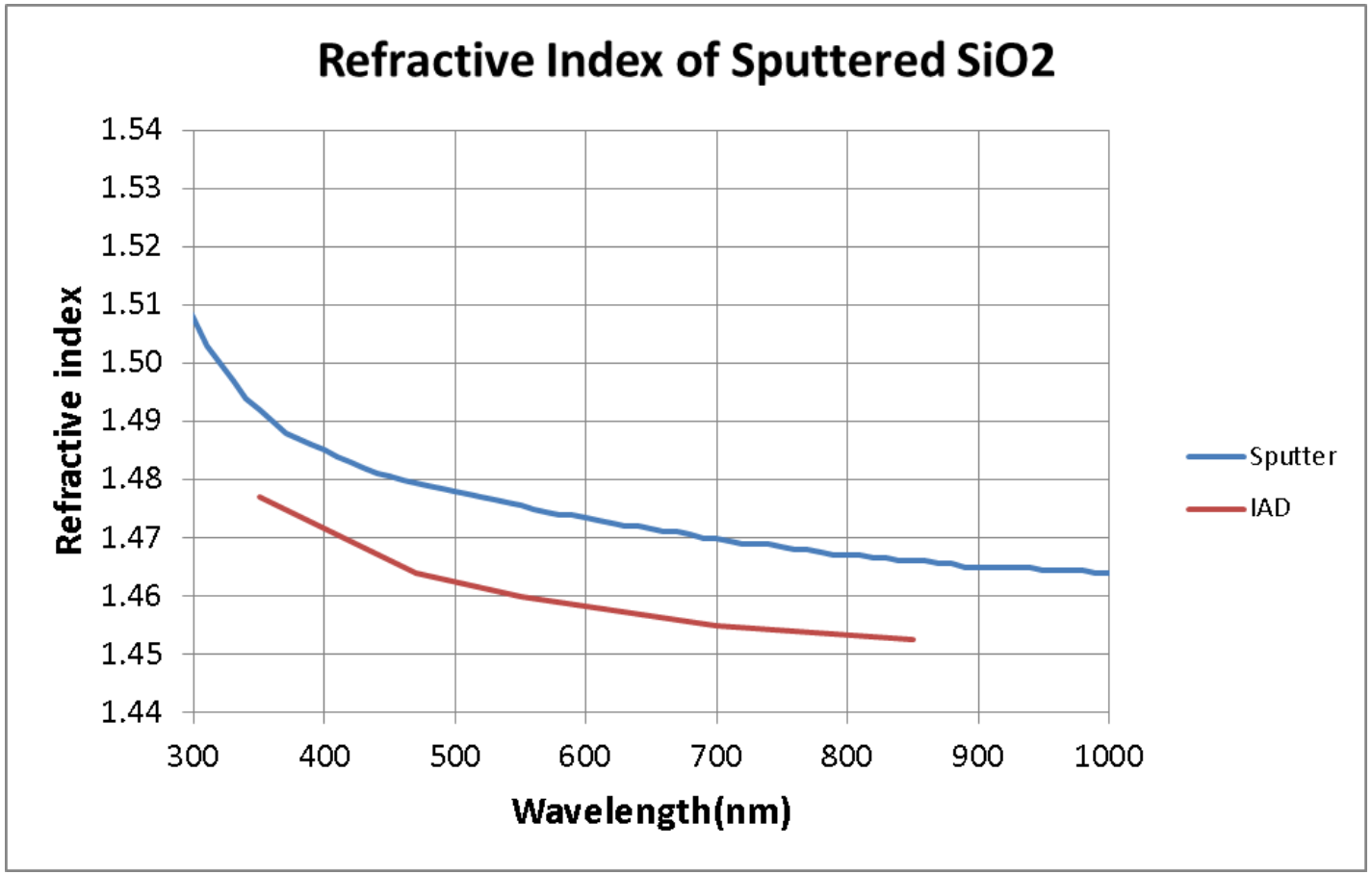
Optical Sputter Coater in Operation



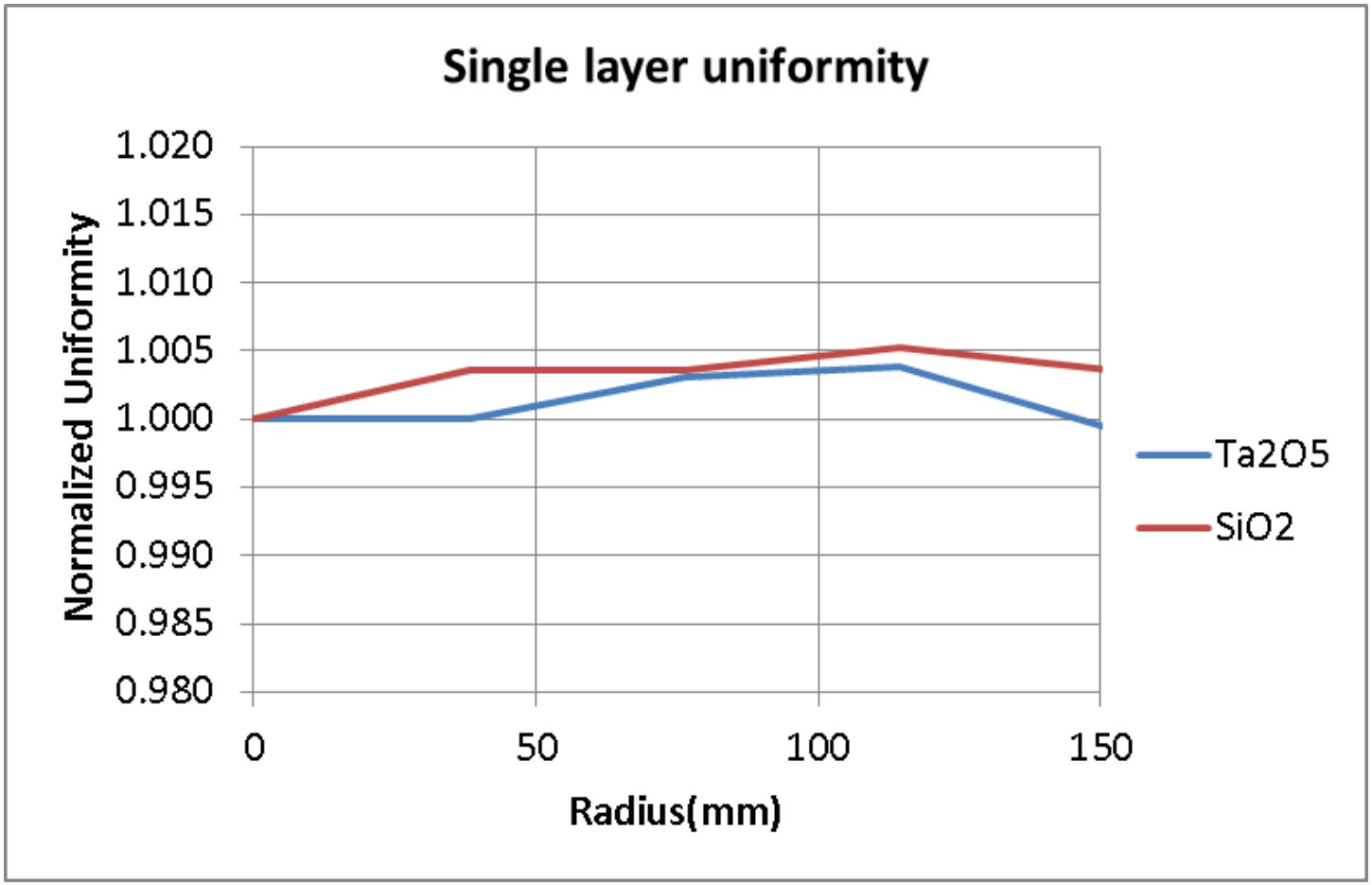
Single layer Ta_2O_5, 5.0 Å/s



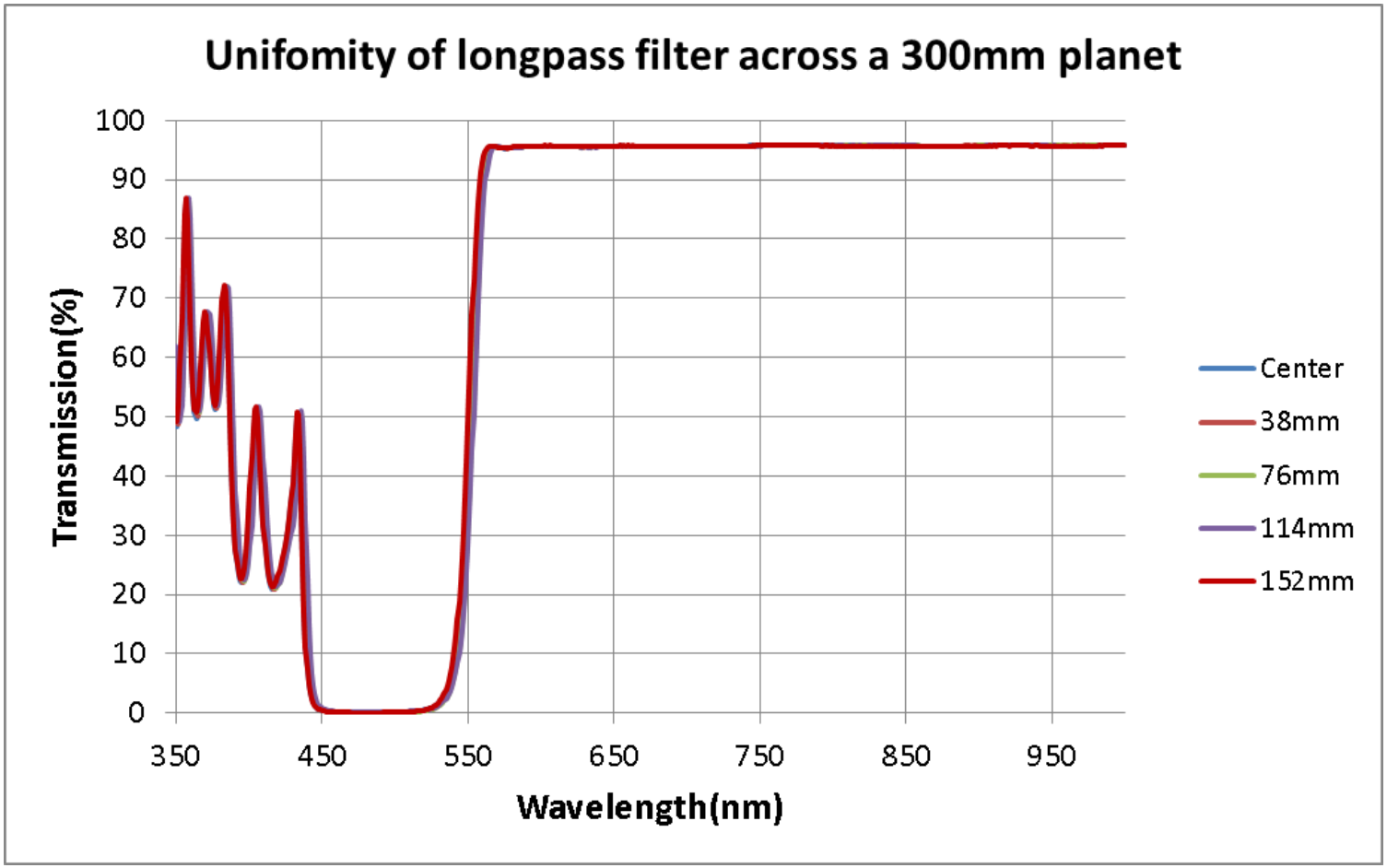
Single layer SiO_2, 6.0Å/s



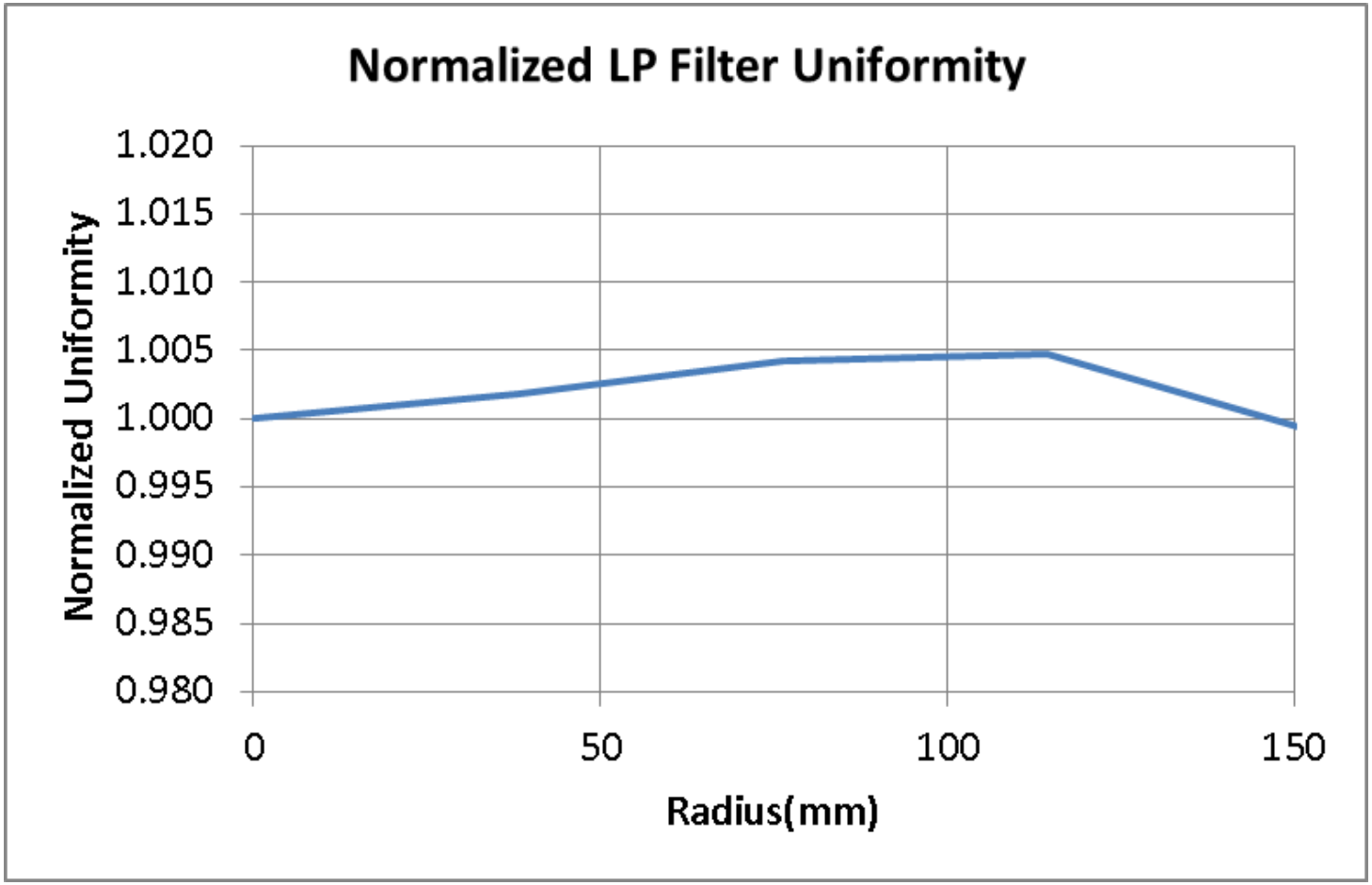
Single layer uniformity across 300mm planets: < ±0.25%



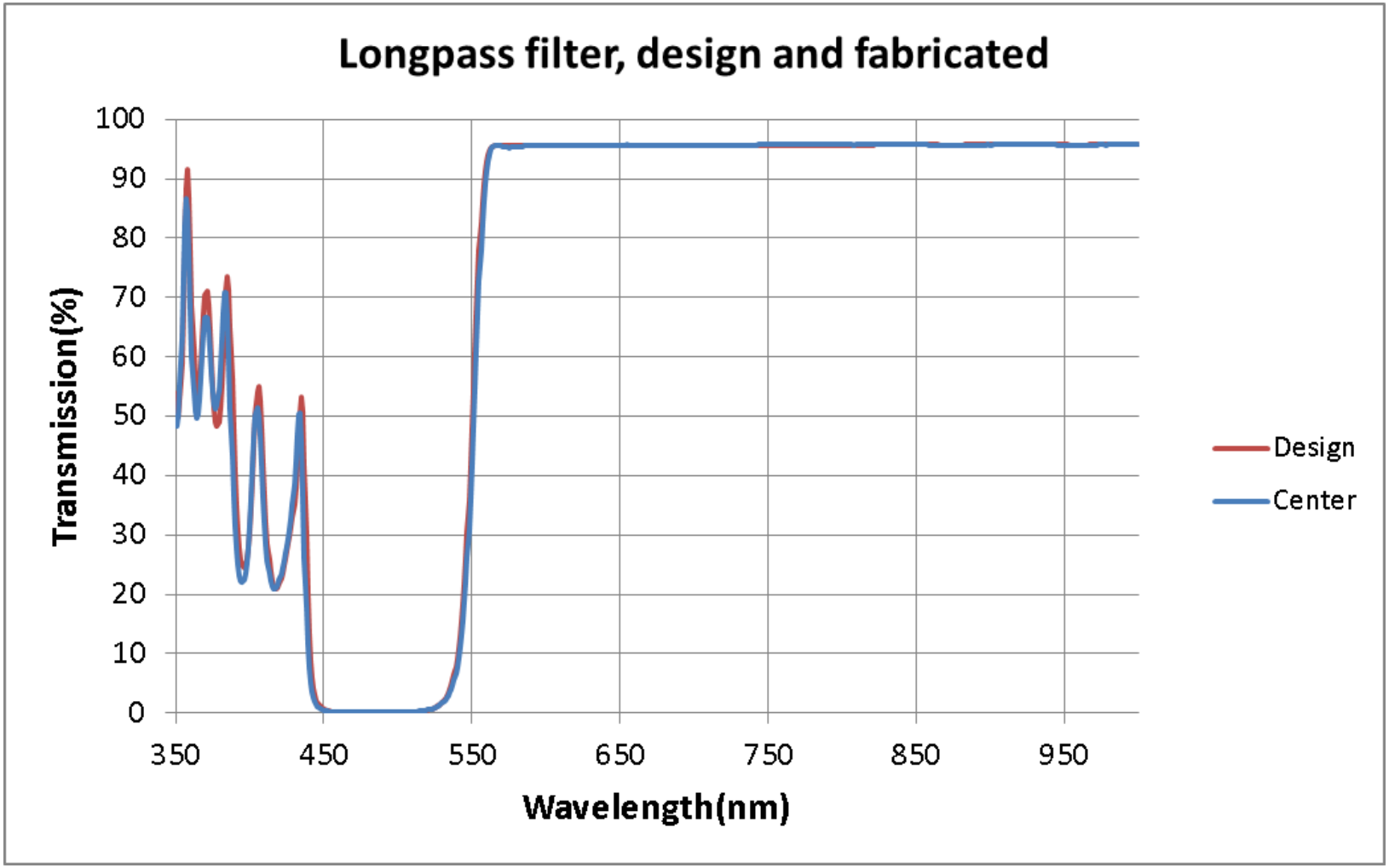
Uniformity of a LP filter across 300mm planets (spectrally measured)



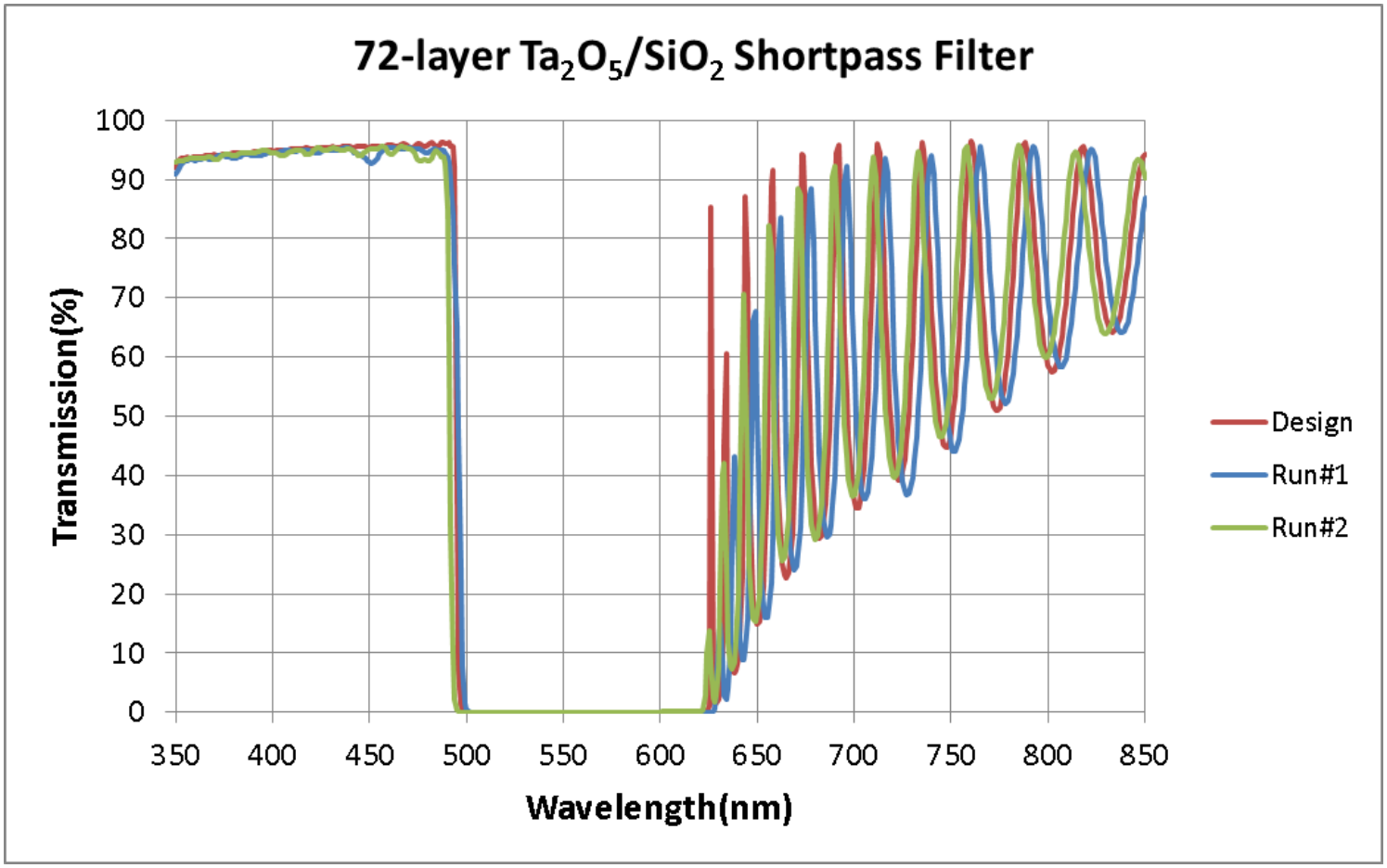
Uniformity of a LP filter across 300mm planets (Normalized)



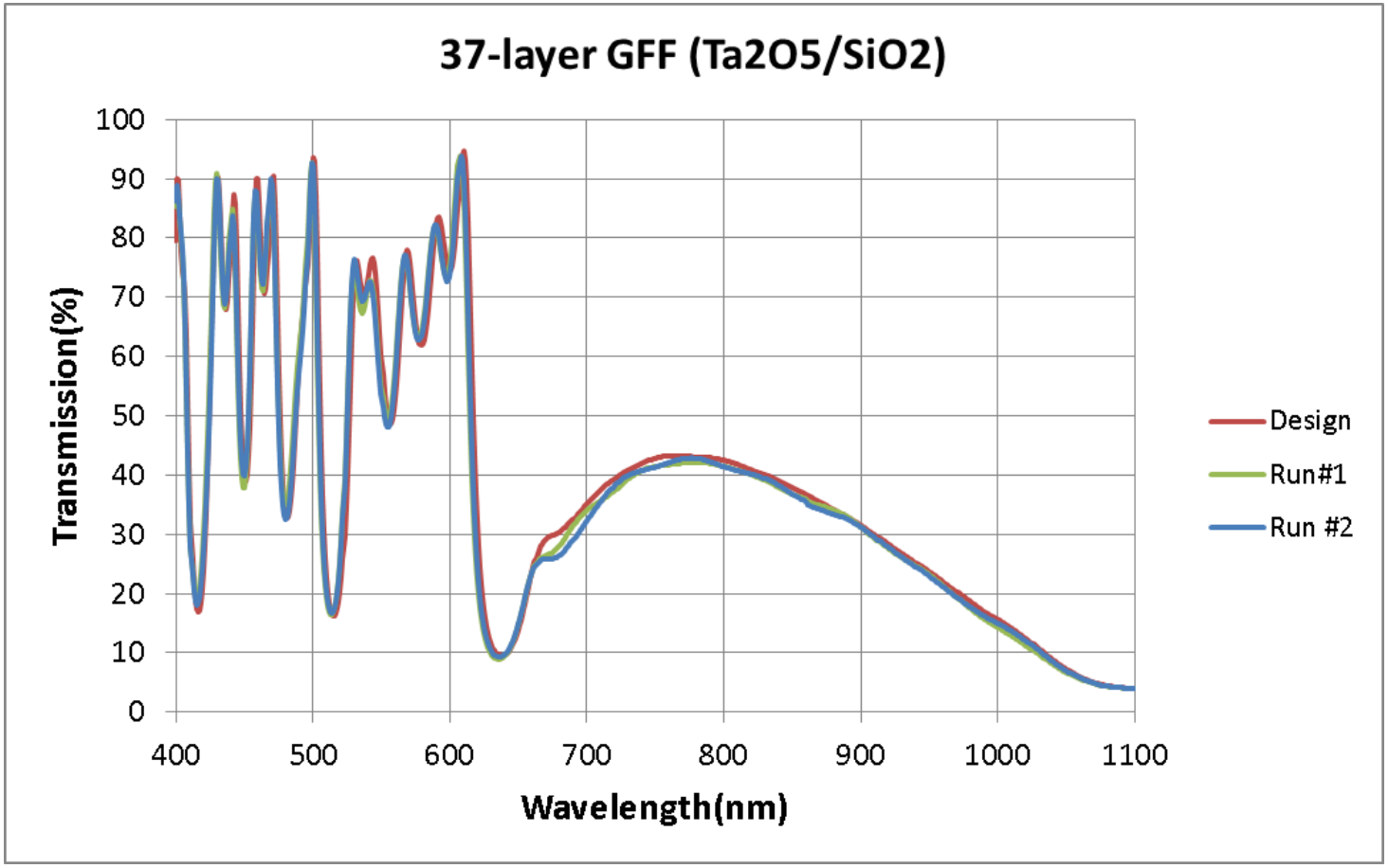
550nm Longpass Filter, 30 layers



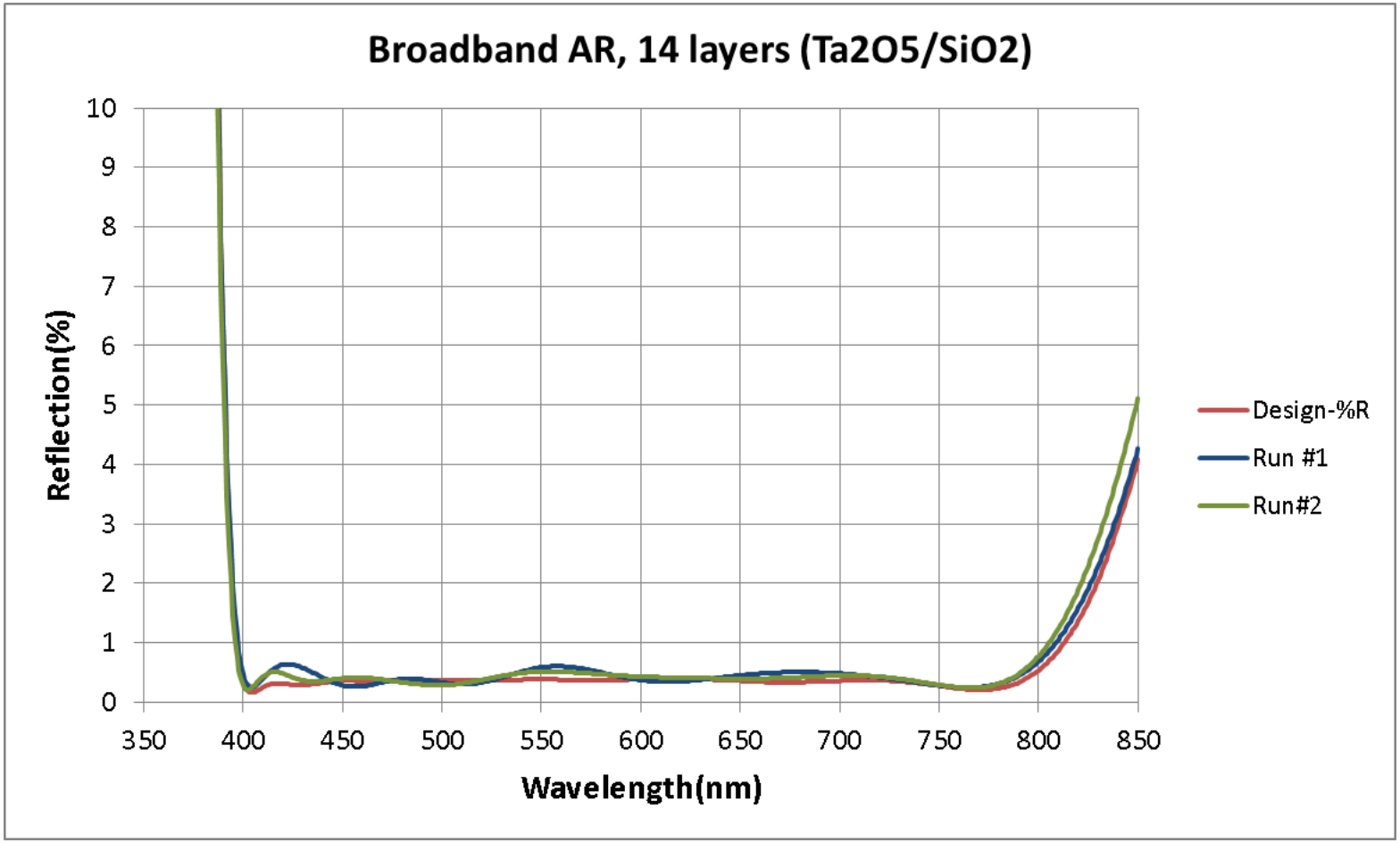
Coating examples : 72-layer SP (Ta_2O_5/SiO_2 , 5.7µm)
Backside uncoated



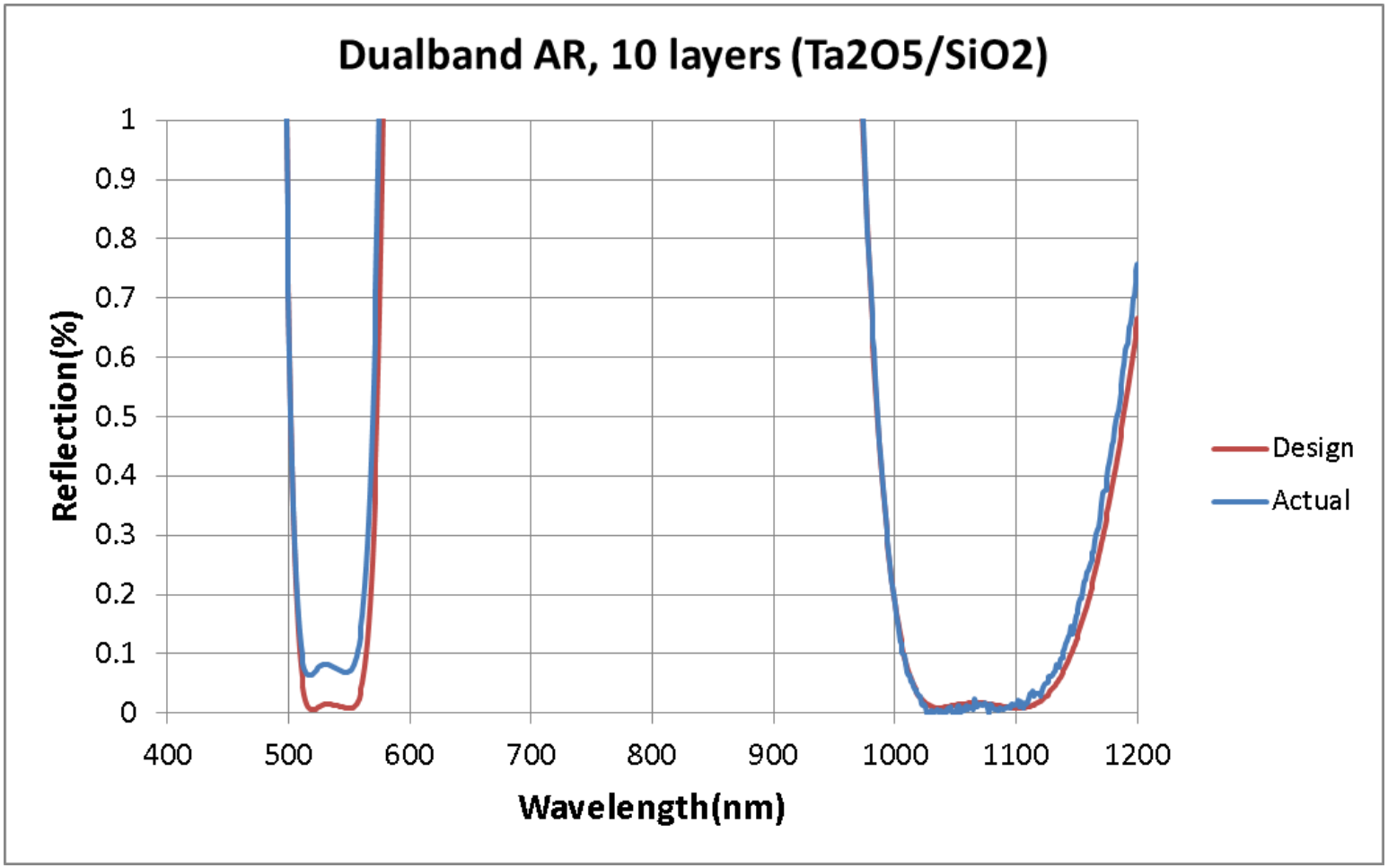
Coating examples : 37-layer GFF (Ta_2O_5/SiO_2, 3.8µm)
Backside uncoated



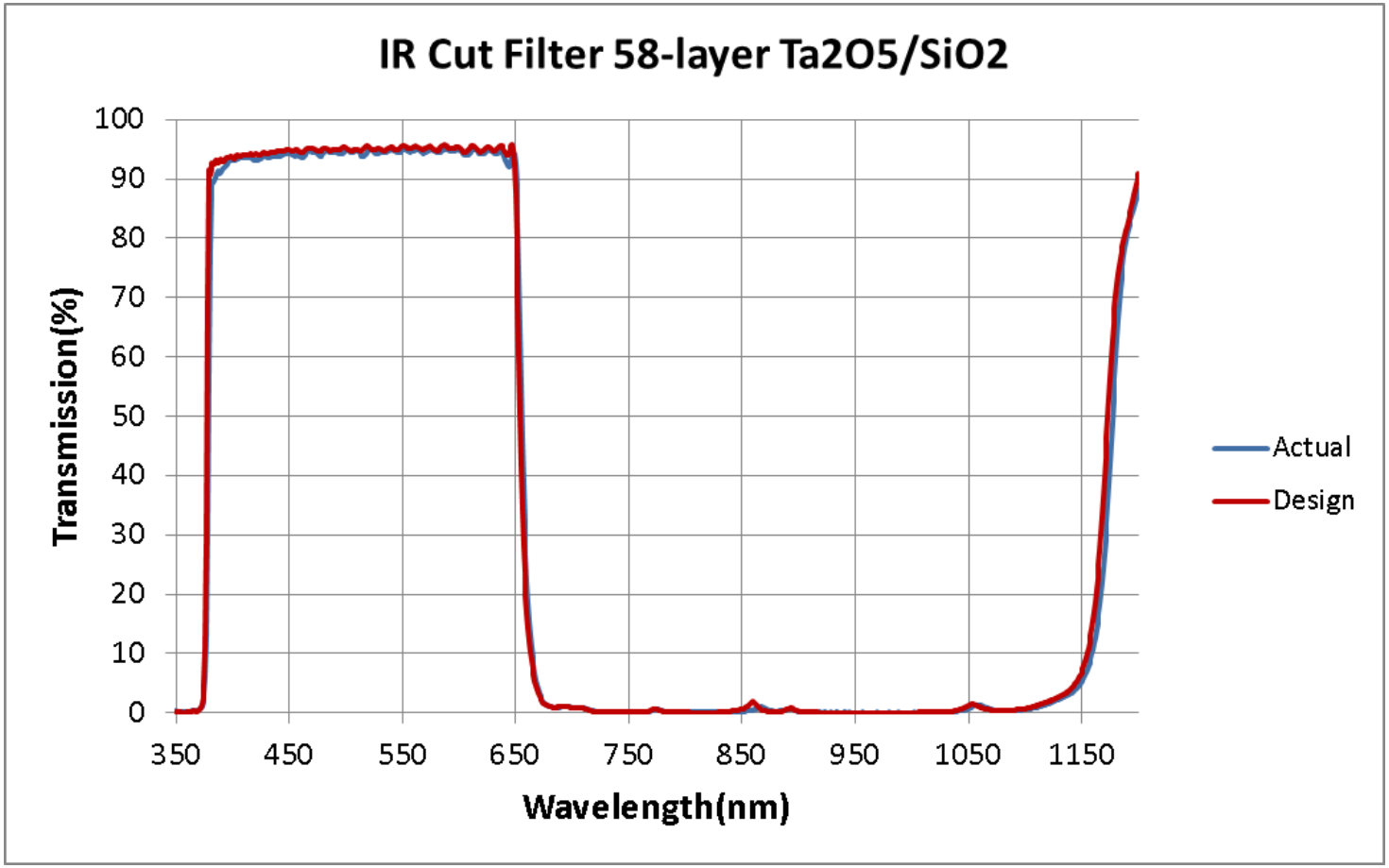
Coating examples: 14-layer BBAR (Ta_2O_5/SiO_2)



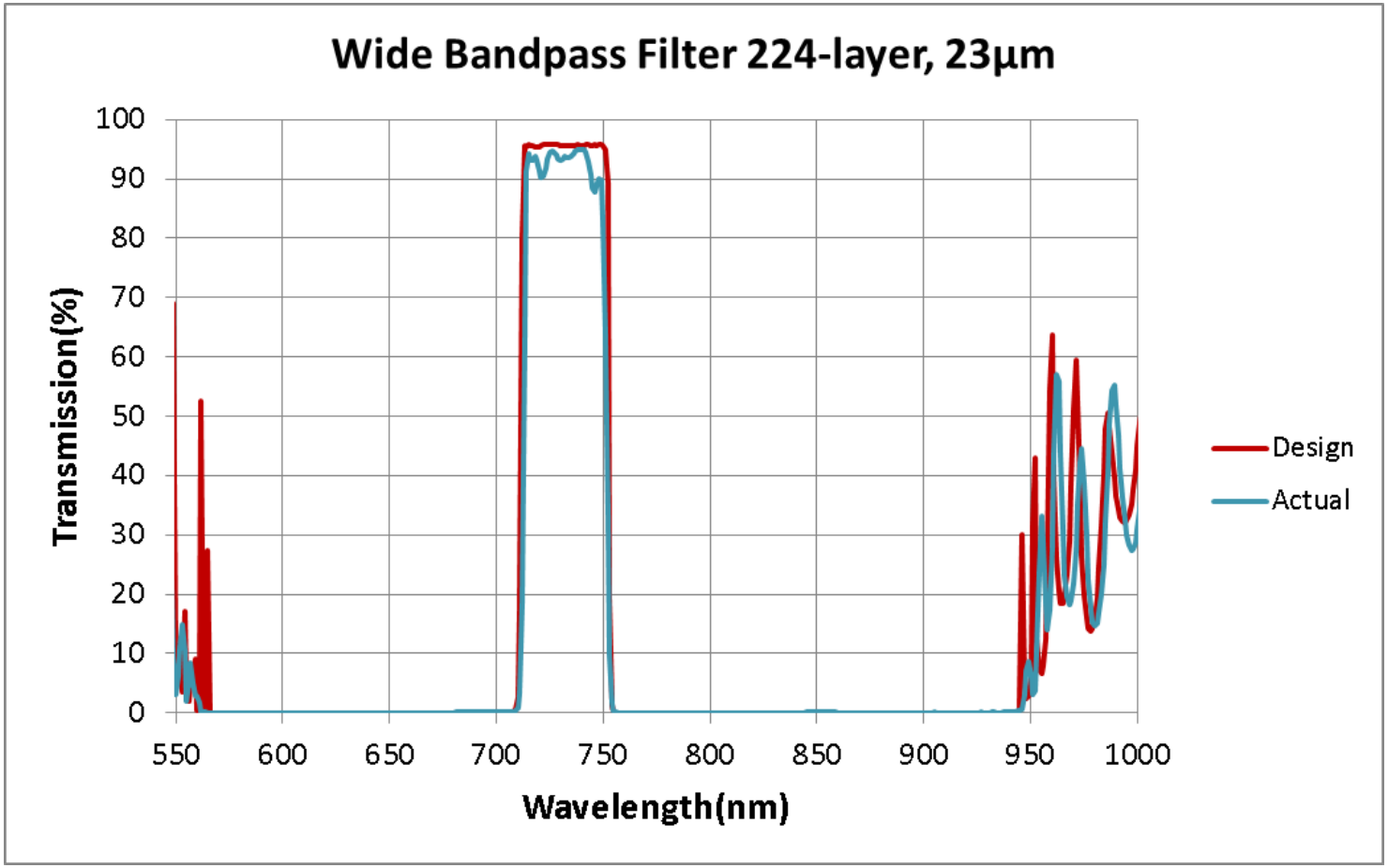
Coating examples: 10-layer Dual-band AR (Ta_2O_5/SiO_2)



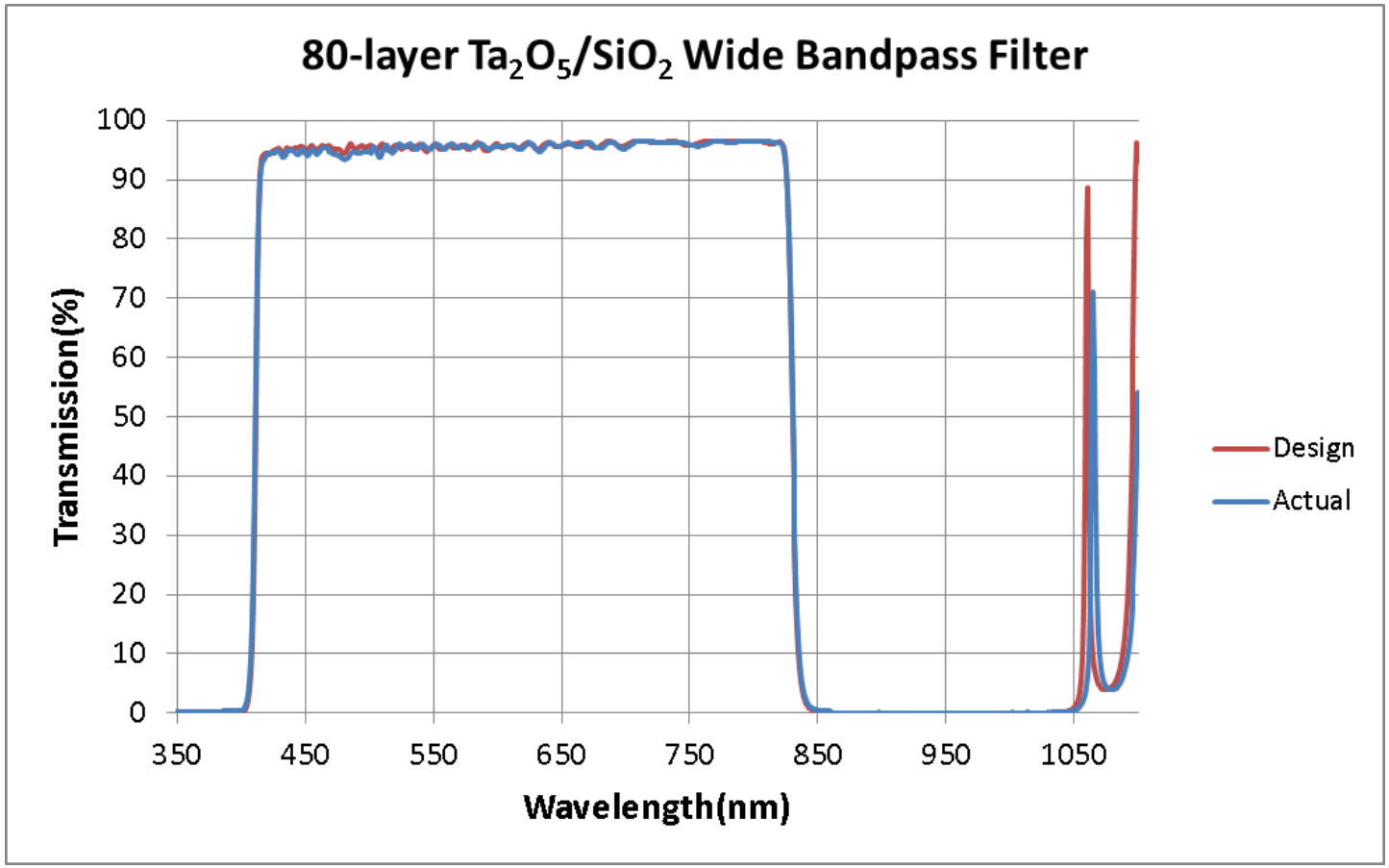
Coating examples: 58-layer IR cut filter (Ta_2O_5/SiO_2)



Coating examples: 224-layer WB(Ta_2O_5/SiO_2, 23µm) Backside uncoated



Coating examples: 80-layer WB(Ta_2O_5/SiO_2, 7.1µm) Backside uncoated



Summary

- Plasma enhanced pulsed DC magnetron sputtering process has been developed
  - Stable and repeatable process: time-power control only
  - Fast deposition rate: Ta_2O_5 : 5Å/s; SiO_2: 6Å/s
  - Dense, low optical loss
  - Large substrate area: six 400mm plates
  - Excellent uniformity: ±0.25% on 400mm planets is achievable