PLANAR OPTICAL WAVEGUIDE COUPLER TRANSFORMERS FOR HIGH-POWER SOLAR ENERGY COLLECTION AND TRANSMISSION

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Outline

1. Background
2. Unique sputtering technology
3. Amorphous dielectric films
4. Applications
5. Summary
Background and Motivation

A large amount of energy from the sun

In a single hour the sun delivers the same amount of energy as consumed by all of humanity in a year – about $5 \times 10^{20}$J, but it’s **highly diluted**

Sun light $\rightarrow$ Electricity

Transport

Electricity $\rightarrow$ Light

Electricity $\rightarrow$ Heat

Sun light $\rightarrow$ Light

No transportation

Light $\rightarrow$ Light

Light $\rightarrow$ Heat

http://www.topnews.in/tidal-interaction-making-earth-and-sun-push-each-other-away-2173555

Background and Motivation

Concentrated sun light into an optical fiber

Sun light $\rightarrow$ Concentration $\rightarrow$ “Directional” Transportation $\rightarrow$ Light $\rightarrow$ Daylighting

Use as light

http://www.selftest.net/media/solar/

Use as heat or storage for later uses

http://fscreenfresnel.en.busytrade.com

En.wikipedia.org

http://blogs.cisco.com

http://www.solarnstuff.com

Strategy and Goal

Concentrated sun light into an optical fiber

- NA mismatch
- Mode size mismatch
- Refractive index mismatch

Optical collector/concentrator

Solar light

Optical transmission line
Concentrated sun light into an optical fiber

Need thin films with $1.4 < n < 2.8$ for 400-1000nm and $k$ as small as possible
Unique Sputtering Technology

Pulsed DC reactive scanning magnetron sputtering with AC substrate bias

Niobium oxide (TEM, scale bar 5nm)
TiO\textsubscript{x} and HfO\textsubscript{x}

TiO\textsubscript{x} and HfO\textsubscript{x}: with and without the substrate bias
TiHfOx

TiHfOx: varied sputtering power
Sunlight into an Optical Fiber
Mode size converter/Out-coupler for LED/LD

Antropy, Inc/Demaray, LLC
US8045832 (Oct. 25, 2011)
US6884327 (Apr. 26, 2005)
The mirror plates will be AR coated with a single layer with refractive index continuously varying.
Sunlight into an Optical Fiber
Ultimate application

http://inhabitat.com

http://www.himawari-net.co.jp
Sunlight into an Optical Fiber
Really ultimate applications

- Eliminate heat engine
- Eliminate working fluid and pipes
- Minimize emission loss and eliminate working liquid/vapor

http://mcensustainableenergy.pbworks.com
www.getsolar.com
www.rainbowskill.com

1m² concentrator for solar daylighting
25m² concentrator for solar thermal power generation
25kW in an optical power over 100m with >90% transmission

Demaray and Kobayashi at the NREL solar furnace

Ernest and Nobby at NREL, Golden CO (Dec '12)
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