**Introduction to Concentrated Solar Thermal (CST)**

In the trough configuration, sunlight is concentrated by parabolic mirrors onto a heat collection element (HCE). The HCE is an absorber tube which runs along the focal point of the trough. The absorbed heat can be stored for several hours in thermal storage tanks. The heat can then be converted into steam to drive a turbine and generate electrical power.

**Advantages of CST:**
- Converts the full spectrum of solar radiation into heat.
- Storage capacity → High capacity factor (>40%)
- Cost-effective
- Lifetime > 20 years
- Effective for large scale generation (>50MW)
- Can supply steam for an industrial process or heating
- Can be used to retrofit an existing fossil fuel fired power plant

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**Optimizing a Solar-Selective Absorber**

The heat collection element or absorber tube is coated with a solar-selective absorber which has two functions:
- Maximize the solar absorptivity
- Minimize thermal emission from its surface

Solar Spectrum (AM1.5) and black body (BB) radiation at 720K have little spectral overlap.

**Ideal absorber**
- Absorptivity $\alpha = 1$ for $\lambda < \lambda = 2.24 \mu m$
- Emissivity $\varepsilon = 0$ for $\lambda > \lambda = 2.24 \mu m$

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**Metal-Dielectric Stacks on Planar Substrate**

**Interference Effects**

When light is impinging on a metal-dielectric stack, it is reflected and transmitted at every interface. The metallic absorbing layers are spaced by dielectric layers creating constructive interference and enhancing absorption at specific wavelengths.

**Simulation Results**

We simulated stacks using the transfer-matrix method and optimized them with a needle optimization technique. We used W and Mo as metals, and MgF$_2$ and TiO$_2$ as the dielectric spacer layers. Layer thicknesses vary from 5 to 100nm.

**Angular Dependence**

The metal-dielectric stacks are wide angular selective absorbers.

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**Metal-Dielectric Stacks on V-grooved Substrate**

**Impedance Matching and Interference Effects**

A sub-wavelength grating (SWG) provides an impedance matching mechanism, since the refractive index changes gradually from air to that of the bare metal. This enhances absorption for wavelengths of the order of the grating. Since the V-grooves are coated with a metal-dielectric stack, interference effects are also governing the spectral behavior.

**Simulation Results**

We simulated coated V-groove gratings using RCWA.

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**Conclusion**

Optimal coatings for planar geometry were modeled to have a thermal emissivity <7% at 720K while absorbing >95% of the incident light. The coated sub-wavelength V-groove gratings can further enhance solar absorptivity to >95% while still keeping thermal emissivity <7%. These structures are predicted to have excellent spectral selectivity and thus good candidates for next generation solar thermal absorbers.