CSIR-NAL Develops Spectrally Selective Coatings for Solar Thermal Power Generation Applications

Preamble. Efficient solar collector is the heart of Concentrating Solar Power (CSP) technologies for producing solar thermal power. To make an energy efficient solar collector, its receiver needs to be deposited with high temperature solar selective coating. At present, it is a closely guarded technology held by a few international players. The National Solar Mission envisages producing 100 GW solar power by 2022, of which ~40% is projected to be produced through the solar thermal route. This would require indigenous development and manufacturing capabilities of receiver technologies along with high temperature solar selective coatings having high absorptance (α) in the solar spectrum region (0.3-2.5 μm) and low thermal emittance (ε) in the infrared spectrum region (2.5-30 μm). Increasing the operating temperature of the receivers reduces the cost of solar electricity. The greatest challenge, however, is to develop a spectrally selective coating which retains its selective optical properties at temperatures ≥580°C in air for a prolonged period of time.

Current Level of Technology. CSIR-NAL has developed several high-temperature spectrally selective absorber coatings on coupon level samples (up to 6") using sputtering processes. These coatings exhibit $\alpha > 0.950$ and $\varepsilon < 0.08$ on stainless steel substrates and are stable in vacuum for 1000 h at 600°C, and in air for 1000 h at 350°C under cyclic heating conditions. *The absorber coating based on a combination of carbides, nitrides and oxides developed on superalloy substrates exhibits an exceptional thermal stability in air up to 600°C under cyclic heating conditions for 262 h, which is FIRST of its kind and has the potential to be used in the receiver technologies without using any vacuum.* The know-how for development of technology for commercial production of the absorber coatings is available with CSIR-NAL.

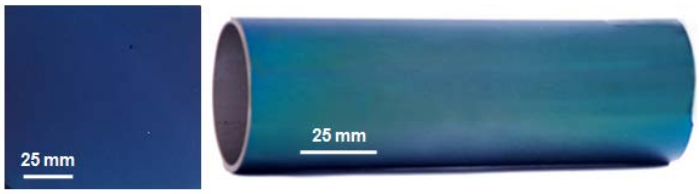

Fig. 1 Photographs of absorber coating on flat and cylindrical samples.

Optical Properties of Spectrally Selective High-Temperature Absorber Coatings

Coating Type	α	$\varepsilon_{82°C}$*	Stability (Temperature / Time)	
			Air	Vacuum
$TiAlN/TiAlON/Si_3N_4$ (*USP/07,585,568*)	0.950	0.07	600°C / 2 h	-
AlTiN/AlTiON/AlTiO (*PCT/IN2012/000451 & 000549*)	0.955	0.08	-	600°C / 100 h
TiAlSiN/TiAlSiN/TiAlSiON/TiAlSiO (*PCT/0182NF2013*)	0.954	0.07	350°C / 1000 h	600°C / 1000 h
TiAlC/TiAlCN/TiAlSiCN/TiAlSiCO/TiAlSiO	0.961	0.07	325°C / 300 h	600°C / 100 h
Carbide/nitride/oxide-based coating (*Patent to be filed*)	**0.936**	**0.15**	**600°C/262 h** (*continued*)	-

Cyclic heating performance in air and vacuum ***High temperature emissivity***

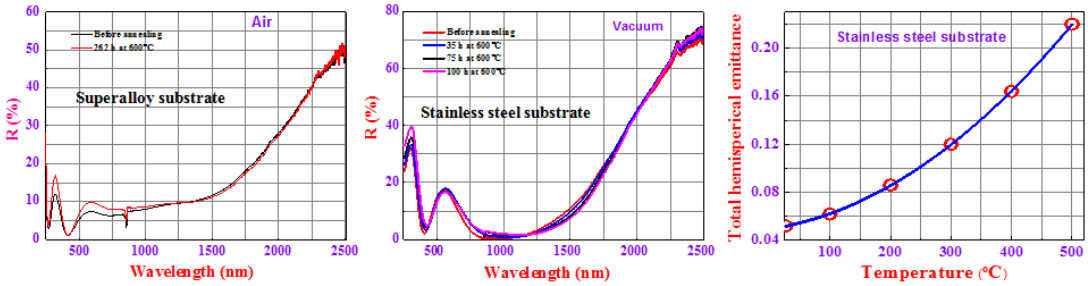

Fig. 2 Performance of the absorber coatings at high temperatures.