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Material innovation in solar selective absorber coatings

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Statement of the Problem: Spectrally selective coatings are common in low and medium temperature solar applications ranging from water solar heating collectors to parabolic trough absorber tubes. They are also essential elements for achieving high efficiency in higher temperature applications such as Concentrating Solar Power (CSP) systems. The mid-temperature coatings are used for solar water and industrial heating applications, while the high temperature absorber coatings are used for thermal power plants. The commercialisation of solar selective absorbers necessities that the expensive oxide coatings are to be replaced by cheaper efficient materials, where the most feasible and practical deposition methods may be used. The material requirements will vary for low and high temperature applications.

Methodology & Theoretical Orientation: In this work, different solar selective absorber coatings are prepared by different methods and their optical absorbance is compared and assessed for solar selective absorbance applications. The materials assessed include natural materials, PVD deposited layers on metal substrates and nanoreinforced polymeric based composite material coatings. The characterisation methods included Spectrophotometery and Fourier transform spectroscopy (FTIR).

Findings: For low temperature applications, it was shown that adding 1.5 and 2.5% nano-graphite particles to a commercial polymer based black coating causes an increase in the optical absorptance to values above 0.96 and a decrease in emittance to values below 0.35, where the highest absorptance and lowest emittance were obtained for 2.5% addition. CuO shows the highest absorbance amongst other natural materials, due to it's amorphous structure and it's black colour. For high temperature applications, AlN was found to have higher absorptance at longer wavelength, whereas TiN has higher absorptance at short wavelength. A new material is proposed for high temperature applications.

Conclusion & Significance: It has been shown that nano-reinforced polymers are good candidates for low temperature selective solar absorbers, while TiN and AlN are good candidates for high temperature applications.

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