

CONCENTRATING SOLAR THERMOPHOTOVOLTAIC ENERGY CONVERSION ENHANCED BY SELECTIVE METAFILM

Qing Ni,¹ Ryan McBurney,¹ Hassan Alshehri,^{1,2} and Liping Wang^{1,*}

¹ School for Engineering of Matter, Transport & Energy,
Arizona State University, Tempe, Arizona, 85287, USA

² Department of Mechanical Engineering,
King Saud University, Riyadh 11451, Saudi Arabia

ABSTRACT. This work performed a detailed theoretical analysis for a concentrating solar thermophotovoltaic (CSTPV) system with a GaSb cell paired with both selective metafilm absorber and emitter. The results showed that the CSTPV system efficiency is between 0.1% and 7.2% when the concentration factor varies from 1 to 100. The analysis on energy loss mechanisms showed that for a metafilm based CSTPV system, half of the incident solar energy is lost through the thermal emission from the top surface of the absorber. In order to enhance the CSTPV system efficiency, the layers thickness of both metafilm absorber and emitter were optimized at 50 suns, increasing the CSTPV system efficiency from 5.8% to 7.8%. The effect of the area ratio of absorber to emitter was also optimized. This work can promote the development of solar thermophotovoltaic system with metafilm absorber and emitter which are easy to be fabricated in large scale.