
核壳 Ag@TiO₂ 纳米流体同步光热蒸发和集热性能的量

摘 要

由于传统能源资源日益枯竭，太阳能的收集和转换研究引起了越来越多学者的兴趣。因为太阳能的有效利用对于能源管理和转换非常重要，而其中具有等离激元共振小型的纳米粒子是光热转换利用中的重要材料之一，其光热特性的好坏决定了太阳光有效波段的能量能否高效利用。

本文采用化学还原法合成了在可见光波段具有较大吸收率的Ag@TiO₂核壳纳米粒子(NPs)。随后，对含Ag@TiO₂纳米颗粒的集热器的光热性能进行了实验研究，考查的性能包括太阳能驱动直接太阳能产蒸汽和纳米流体集热两方面，同时还考虑了纳米粒子浓度和光照强度对蒸发及集热性能的影响。

结果表明，Ag@TiO₂纳米流体可在较短太阳照射时间范围内直接引发蒸汽产生，即使在1sun（1sun=1KW/m²）的光照强度下也是如此。当纳米流体浓度仅为200ppm时，由于纳米流体表面等离子体共振引起的局部加热效应，蒸发效率可达53.6%。此外，实验研究还发现具有较低纳米粒子浓度的纳米流体在光照过程中具有较高的温升，这是因为吸收的太阳能优先转移成潜热焓，并消耗于蒸汽产生，而不是加热纳米流体。

关键词：光热转换、Ag@TiO₂纳米流体、蒸汽产生、热捕获、

Title Measurement on synchronous photothermal evaporation and heat collection performance of core-shell Ag@TiO₂ nanofluids.

Abstract

Due to the depletion of traditional energy resources, more and more scholars are interested in the study of solar energy collection and conversion. Because the effective utilization of solar energy is very important for energy management and conversion, and among them, small-sized nanoparticles with plasmon resonance are one of the important materials in photothermal conversion and utilization, and their photothermal characteristics determine whether the energy in the effective band of sunlight can be efficiently utilized.

For this reason, Ag@TiO₂ core-shell nanoparticles (NPs) with great absorptivity in the visible light band were synthesized by chemical reduction method in this work. Subsequently, the photo-thermal performance of the collector containing Ag@TiO₂ nanoparticles was experimentally studied. The investigated performance included solar-driven direct solar steam generation and nano-fluid heat collection, and the effects of nanoparticle concentration and light intensity on evaporation and heat collection performance were also considered.

The results showed that the Ag@TiO₂ nanofluids can be used for direct steam generation with a short period of solar irradiation time, even at the illumination intensity of 1sun(1sun=1kW/m²). An evaporation efficiency of 53.6% can be achieved when the NP concentration is only 200 ppm owing to local heating induced by the surface plasmon resonance of the NPs. In addition, it is found that the nanofluid with a lower NP concentration has a higher temperature rise during illumination. Our findings also showed that the absorbed solar energy is transferred preferentially into latent heat enthalpy and consumed for steam generation instead of heating the nanofluids.

Key words: Photothermal conversion; Ag@TiO₂ nanofluids; Steam generation; Heat capture

主要符号表

英文字母

希腊字母

		θ	接触角
		η	蒸发效率
A	横截面积		
c_p	水的比热		
D	仪器内径		
H	广义高度		
h_{lv}	蒸发潜热		
k	室温		
K	纳米流体温升		
$\dot{m}$	质量流量		
m_v	剩余水质量		
q	太阳通量		
ΔT	温度变化量		

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