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Mesoporous SiO_2 nanoparticles in PDMS composites: encapsulant for photovoltaic cells aiming to improve environmental degradation

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Introduction

Used in photovoltaic modules, the encapsulant is a protector film deposited on the solar cells that protects them against humidity, dust and UV radiation. The polymer ethylene vinyl acetate (EVA) is used on a large scale as an encapsulant, However it can present rapid degradation, reducing the efficiency of the photovoltaic modules.[1]

Objective

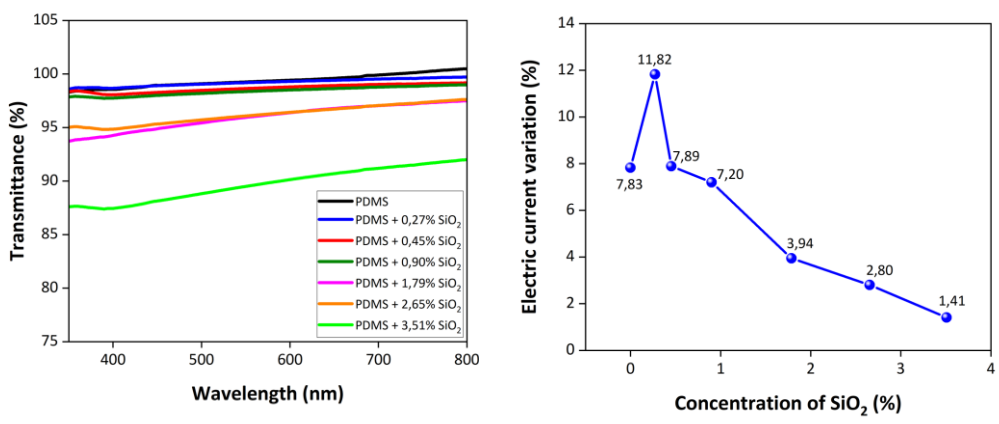
This work proposes the use of PDMS encapsulate, reinforced with SiO2 nanoparticles to give greater thermal and UV stability, hydrophobicity, extending the useful life of photovoltaic modules. [2]

Methodology

Samples of photovoltaic cells coated with pure PDMS and with the addition of nanoparticles of SiO_2 in different mass concentrations (0.27, 0.45, 0.90, 1.79, 2.65 and 3.51%) were prepared. The polymer was prepared using PDMS and curing agent in a ratio of 1:10. Mesoporous SiO_2 nanoparticles, with sizes of 200 nm and pores of 4 nm were dispersed in 98% ethyl alcohol and agitated manually until complete dispersion and then mixed to the polymer. The encapsulation of cells was performed by casting, in which the material was deposited on the cell surface and curing occurred under temperatures of 100ºC for 30 minutes. The cell's energy generation was tested before and after coating in a solar simulator. An analysis of the transmittance of the films by UV-Vis spectroscopy was also performed.

Results and Discussion

The transmittance of pure PDMS films and PDMS with SiO2 at concentrations 0.27% to 0.90% (m/m) remains in the range of 98 and 100% in the visible region (Fig. 1), while at higher concentrations there was a reduction.



Figur1 1. Transmittance of PDMS films in different concentrations of SiO_2 nanoparticles. Variation of the electric current with increasing concentration of SiO_2 nanoparticles in PDMS films. Source: Author

The films with SiO_2 concentration above 0.90% did not show significant increase in energy generation due to the reduction of transmittance. Then, after aging, samples with 0,9%wt/wt of SiO2 present the best result reducing the rate of degradation and lose efficiency after irradiation with UV light.

Table 1. UV light irradiation into aging equipment.

Variação da Eficiência Δ(%)		
Amostra	***0 h – 2.000 h***	***0 h – 3.000 h***
PDMS	-25%	-76%
PDMS + 0,27% SiO_2	35%	-48%
PDMS + 0,45% SiO_2	-0,74%	-51%
PDMS + 0,90% SiO_2	0,90%	-28%
PDMS + 1,79% SiO_2	-67%	-80%

Conclusion

The encapsulants presented adequate transmittance and improvement of the solar cell energy generation. Concentrations of SiO2 close to 0.27% (m/m) are promising for application in photovoltaic panels. In the next step, the film life will be tested.

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