Waste heat from thin-film photovoltaic modules

Is there a thin-film photovoltaic recycling process?
The Colorado School of Mines developed a recycling process for PrimeStar Solar's CdTe PV modules , . Besides those processes designed for commercialization, thin-film photovoltaic recycling was investigated in several research and demonstration projects in the United States of America, Japan and Europe.

Are PV thin film modules recyclable?
Already in the 1990s first recycling strategies for PV thin film modules were being developed (Bohland et al., 1997, Bruton et al., 1994, Eberspacher et al., 1994, Fthenakis et al., 1996, Menezes, 1996, Wambach, 1998).

Why do we need a sustainable recycling of photovoltaic modules?
The rapid development and growth of the photovoltaic market and the estimated quantities of photovoltaic waste in the near future, as well as the scarcity of semiconductor materials, demand a sustainable recycling of PV modules.

What is the energy required for recycling a photovoltaic module (PVM)?
The energy required for recycling includes the transportation of waste PVMs, thermal treatment or incineration of polymers, other treatments (acid leaching, sieving, neutralization), and metals recovery . 3.1. Key materials in photovoltaic modules (PVMs) for recycling

What is a photovoltaic recycling program?
In July 2007, the photovoltaic industry founded the PV Cycle Association in Brussels, whose purpose is the creation of a voluntary industry-wide take-back and recycling program for end-of-life modules in Europe (PV Cycle, 2008). 3. Materials Within the RESOLVED project the recycling of thin film modules was performed using CdTe and CIS modules.

Why do we need to recycle end-of-life photovoltaic modules?
Recycling of end-of-life photovoltaic modules (PVMs) attracts the attention of researchers due to valuable materials present in it. With the advances in the PVM manufacturing newer materials are used recently,including silicon wafer and thin film solar cells dominate the market and are key PVM categories requiring recycling.

The second-generation photovoltaic solar cells are thin film solar cells based on CIGS, CdTe, amorphous silicon, etc. ... of CdS and the interface between CdS & CdTe are optimized with post-deposition treatments like CdCl 2 treatment and heat temperature processing. In the last two decades, cadmium zinc telluride (CdZnTe) thin films are ...

A sustainable recycling of photovoltaic (PV) thin film modules gains in importance due to the considerable

growing of the PV market and the increasing scarcity of the resources for ...

In this paper, we attempt to show how to manage panels, which have been withdrawn from the exploitation and are stored on landfills as a photovoltaic waste. The next generation of PVs is intensively developed, and ...

Different methods of recycling the photovoltaic panels mentioned in the literature (Libby et al., 2018; Garlapati, 2016; Latunussa et al., 2016) andra et al. (2019) presents the management of PV cell modules in an eco-sustainable two-stage thermal process. However, individual merits and demerits exist in the recent view"s first solar proposed chemical treatment ...

Due to its relatively low cost and its already achieved efficiencies exceeding 10%, thin film photovoltaic modules are a very promising alternative for the generation of energy [1]. ... An efficient coupling system using a thermophotovoltaic cell to harvest the waste heat from a reforming solid oxide fuel cell. International Journal of Hydrogen ...

Compatible with various PV modules (crystalline Si, thin-film Si, CIS systems) Compatible with PV broken glass modules. High recycling rate (99% and above) Material recycling rate: 82% (99% and over for glass, aluminum, cells, wires) With the inclusion of heat recovery, the overall recycling rate is 99% and over. Increased CO 2 reduction ...

Mizoshiri et al. designed a thin film TEG module and analyzed the surface temperature distribution using a finite element ... PV modules produce waste heat which can be transferred from PV to TE. ... Energy conversion efficiency of a novel hybrid solar system for photovoltaic, thermoelectric, and heat utilization. IEEE Trans Energy Convers, 26 ...

Van Sark investigated the PV-TE system which attached the TEG to PV modules to convert waste heat into electricity, as shown in Fig. 12. The author also performed a ... Overview of temperature coefficients of different thin film photovoltaic technologies. 25th European photovoltaic solar energy conference and exhibition/5th world ...

The level of efficiency of thin-film modules is between 6 and 10%. It means for these solar cells to achieve the same performance as the crystalline modules, thin-film modules need to be installed in a comparatively larger area. The performance of thin-film solar modules is reduced due to degradation.

Recycling processes of silicon crystalline panels, finalized to separate PV cells from the glass, involve the removal of the EVA (Ethylene Vinyl Acetate) layer through different ...

CIGS Based Thin Film Photovoltaic Modules Final Technical Report 5 February 1998-4 February 2001 National Renewable Energy Laboratory 1617 Cole Boulevard Golden, Colorado 80401-3393 NREL is a U.S. Department of Energy Laboratory Operated by Midwest Research Institute o Battelle o Bechtel Contract No.

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CdTe is a near perfect material for PV application with a direct band gap of ~1.5 eV that is closely matched to the terrestrial solar spectrum and a high optical absorption coefficient where less than 1 um thickness is adequate to absorb the incident light. CdTe thin film solar cell and module technology has validated the economies of scale that were projected for thin film ...

The paper presents, the new strategies developed to extract TCO coated glass from thin film amorphous silicon PV end-of-life modules. The recycling of thin film PV modules is based on a very simple approach that includes chemical, thermal and mechanical treatments. Optimised solutions of 1 M NaOH and 1 M KOH were used to extract TCO coated glass.

BP Solar"s Apollo thin film photovoltaic module fabrication process is based on the thin film semiconductors cadmium sulphide (CdS) and cadmium telluride (CdTe). It is a leading technology with aperture area efficiencies of more than 10% reported for devices of area 706 cm 2 and 7.8% for modules with aperture areas up to 4,540 cm 2 [1].

The market share (Supplementary Table S4) of the three types of PV modules, c-Si, CdTe and CIGS thin-films, were used to estimate PV waste by technologies in provinces. Generally, large-scale power stations mostly utilize polysilicon modules, whereas thin-film PV modules are mainly used in distributed power stations [46]. Thus, we assumed that ...

The other is that the heat source is abundant, varying from industrial waste heat to solar heat, geothermal heat, etc. Radioisotope TEGs (RTGs) are one of the most successful TE devices and are currently used for space missions [37]. RTGs are also a preferred power source for lunar surface and deep-space exploration, and they are also used for ...

A review article on recycling of solar PV modules, with more than 971GWdc of PV modules installed globally by the end of 2021 which includes already cumulative installed 788 GW of capacity installed through 2020 and addition of 183 GW in 2021, EOL management is important for all PV technologies to ensure clean energy solutions are a sustainable component of the ...

The author attests to the difficulty in implementing CdTe recovery processes from thin film modules because of the small quantities of these materials present in each module. In order to recycle these compounds, the authors propose the use of a series of mechanical separation techniques.

Global exponential increase in levels of Photovoltaic (PV) module waste is an increasing concern. The purpose of this study is to investigate if there is energy value in the ...

Some studies have proven that waste or end-of-life (EOL) photovoltaic (PV) modules contain a large number

of toxic and harmful substances, which have high leaching toxicity and will lead to soil and water pollution (Azeumo et al., 2019; Mahmoudi et al., 2019a; Lisperguer et al., 2020) addition, waste PV modules will produce solid waste with the poor ...

Cadmium telluride (CdTe)-based cells have emerged as the leading commercialized thin film photovoltaic technology and has intrinsically better tempera...

Different techniques can be indicated depending on whether we recycle zinc-based photovoltaic panels or thin-film photovoltaic panels . With silicon-based photovoltaic panels, the glass that makes up the coating is separated from the aluminum parts that represent the frame. In particular, the glass is 95% recyclable; all the external metal ...

Other than CdTe, the recycling of thin-film PV modules is still in its early stages. But, as waste volumes and the corresponding amount of waste treatment knowledge increase, the process will be improved [13, 14]. Also, CdTe out of all the other technologies mentioned is the second most deployed (15% globally), and not phasing out (like a-Si ...

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