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Next-Generation Approaches to PV Recycling Fostering Green Technology and Production

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ABSTRACT

Photovoltaic (PV) systems, which stand out among renewable energy technologies, play a crucial role in global efforts to combat sustainability and climate change. As the technological diversity and application areas of PV modules continue to expand rapidly, managing the end-of-life PV modules has become a key sustainability challenge towards green technology and green production. Given that PV modules have an average lifespan of 30 years, it is essential to provide effective waste management strategies for recycling critical minerals and reducing the load of landfilling and CO_2 emissions. This includes recovering valuable minerals for reuse in production and implementing eco-friendly processes to minimize their impact on the environment. PV recycling methods can be categorized into mechanical, chemical, and thermal approaches, which are explored both through conventional and innovative strategies. In addition, emerging alternative approaches are being developed with an innovative perspective. This study focuses on effective and innovative recycling methods for PV modules and evaluates their environmental impact. In particular, it compares advanced solvents that achieve over 90% delamination efficiency in breaking down ethylene vinyl acetate (EVA), the primary encapsulant material in PV modules, assessing their sustainability within the broader recycling framework.

Keywords: CO_2 emissions, PV recycling, sustainability and climate change, waste management