Transparent Wood as a Sustainable Material for Photovoltaic Applications

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Energy plays a key role in economic growth and development. As the population and economy grow, the energy demand also grows, and in the context of the climate crisis, renewable energy sources in particular are gaining increasing importance. Solar energy transformed through photovoltaic cells has become one of the main renewable sources. Research, development and production of photovoltaic cells have made enormous progress in recent decades. Investments are focused not only on increasing efficiency through new materials, but also on the ecological recycling of cells after their end of life. The production of traditional photovoltaic cells mainly uses high-purity monocrystalline and polycrystalline semiconductors (silicon, gallium arsenide, silver, germanium, indium, selenium, tellurium), glass and plastics for cell protection or perovskite for the production of low-cost photovoltaic cells, and aluminium for the production of cell frames. On the other hand, they also have disadvantages, such as e.g. fragility and high thermal conductivity in the case of glass, lower stability at higher temperatures, toxicity (presence of heavy metals such as lead, cadmium, bismuth, arsenic), shorter lifetime in the case of perovskite, and sustainable and ecological disposal and recycling of photovoltaic cells remains problematic.

For the above reasons, manufacturers and scientists are focusing on new, more stable and ecological materials. One of the most promising is transparent wood, which is produced by chemically removing lignin and other components from natural wood fibres and their subsequent impregnation with a transparent polymer (Epoxy, MMA, PMMA, PVP, PVA, etc.). The result is a material with excellent optical properties and mechanical strength, light, tough, with low density and thermal conductivity. Transparent wood is used in construction, for example, in window production, as a light-transmitting material for energy-efficient buildings (smart windows, roofs), as well as in modern architecture (interior and exterior design elements). However, due to its combination of transparency (up to 90%) and thermal insulation properties (λ = 0.03 to 0.07 W m^{-1} K^{-1}), it is also of particular interest for the production of solar panels. It replaces traditional silica glass as a more economical and environmentally friendly alternative. Compared to conventional silicon solar cells, which require energy-intensive production processes, transparent wood has a significantly lower carbon footprint (silicon photovoltaic cells : transparent wood = 25 to 60 g CO_2e/kWh : 5 to 12 g CO_2e/kWh). Its renewable origin and lower environmental impact make it an eco-friendly and sustainable choice for widespread use in solar technologies.

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