Development of a High-Efficiency Ultraviolet (UV) Energy-Harvesting Cell Using Zinc Oxide (ZnO) and Nanotechnology: Integration of TiO2 Nanocoating, SiO2 Nanoparticles, and Piezoelectric Devices With Polysilicon Cooling System for Enhanced Renewable Energy Conversion and Sustainability

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This project addresses key global issues identified in the UN Sustainable Development Goals (SDGs), particularly the lack of renewable energy sources and the world's overreliance on non-renewable resources, which account for over 80% of global energy consumption. This reliance leads to air pollution, global warming, and rising temperatures. Another issue is the underutilization of solar energy in the ultraviolet (UV) spectrum. Despite UV indexes reaching over 11 in some areas, conventional solar technologies fail to harness this energy efficiently. The project presents a solution through the development of an advanced UV energy-harvesting cell using zinc oxide (ZnO), enhanced with nanotechnology. UV cells typically face low efficiency, with only about 20% of incident UV being converted into usable energy. This design uses a TiO2 nanocoating for optimal UV absorption, SiO2 nanoparticles for even UV distribution, piezoelectric nanodevices to capture mechanical energy from surrounding vibrations, and a ZnO layer for efficient conversion of UV rays to electricity. Tests revealed a drop in efficiency at high temperatures, so a polysilicon cooling system was added to maintain optimal conditions. As a result, the UV cell achieved a 40% energy conversion rate—significantly higher than the 15–22% seen in traditional solar panels. Power output rose from 1.48 watts per minute to 4.27 watts in three minutes. Though more expensive upfront, the cells are longer-lasting and more efficient, offering a sustainable and cost-effective energy solution.

Awards Won: