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# Synthesis and Characterization of Tin-Based Nano-Structure Thermoelectric Materials and Device Fabrication

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**Abstract.** In the 21st century, the most pressing challenges our planet faces are the development and use of energy in a manner that does not hurt the environment. In 2013, the globe generated a total of 23322 TW of energy, of which India produced 1193 TW, or 5.1 percent. As a result of a massive rise in global energy consumption and an extraordinary addiction on ignition of non-renewable vestige fuels to supply this demand, global warming, acid rains, air pollution, the loss of the ozone layer, etc., are all consequences of this. Climate change, rising energy consumption, and the depletion of traditional fuel sources all point to the necessity of looking into substitute energy sources and technology for conversion of energy. Because of this, it is critical to expand research into solar, wind, geothermal and thermoelectric (TE) energy conversion technologies.

***Keywords: Nano structure, Fabrication, Nono-Materials, Synthesis***

## Introduction

There are around 896602 MW of power generated in Delhi, with a total of 2181 MW of it coming from solar (2050 MW) and waste energy conversion. A total of 175 GW of renewable energy is expected to be generated by India's renewable energy sector by the year 2022, which includes the production of 100GW of solar power and 60GW of wind power, as well as 10GW of biosolar power and five GW of hydropower. With regards to its influence on our environment, India ranks 3rd in the world for CO2 emissions from fossil fuel use and coal combustion despite its ability to produce 523.34 Mtoe of energy and import 254.70 Mtoe of energy each year. More functioning energy systems are needed to address these concerns. A key worry in the energy supply and demand scenario is the amount of wasted heat. On average, engines burn around 40% of their fuel energy, 30% of that energy is compressed in engine radiator coolant, 5% of that energy is lost to emission and friction, and just 25% is used to move the vehicle. [1] In light of the fact and proportion of wasted energy, there is a need to improve the related technologies to maximize waste useless energy usage. According to US energy research, Fuel is wasted in the exhaust system of 200 million small trucks per year. Over 1.72 billion gallons of oil are thrown away in the United States each year attributed to the reason that approximately two-thirds of the energy available in power plants and companies is squandered. In order to solve this issue, we must adopt a low-cost, high-efficiency, and ecologically friendly energy infrastructure. The thermoelectric energy conversion, where heat is directly turned into electricity or other way around utilizing thermoplastic materials, has attracted fresh interest in recent years. With the solid-state operation, no moving parts or chemical interactions and long-term reliability, this energy conversion technology has several benefits. These include: no harmful residues, huge scalability, maintenance-free operation and a long lifespan of dependable operation. It is achievable to use thermoelectric materials to turn waste heat into energy or the other way around. thermoelectric devices have a unique capacity to be used for application such as squander heat harvesting and environmentally friendly cooling. There is great interest in applying this ability. Figure 1 shows the Peltier effect.

**Methodology**

Material structure may be studied using the non-destructive XRD method. For identifying and characterizing unknown crystal materials, it works well [12]. The crystallinity of the material, the lattice parameter, the type of the phase present, the presence of impurities, and the grain size may all be determined by XRD [13]. The electrons in atoms in a substance either transmit or scatter X- rays that strike it. This is the fundamental concept. The crystal lattice's atomic planes constructively interact with the dispersed waves. Calculation of scattering angle using Bragg equation: 2dsin(X-ray wavelength) = (Distance between interatomic planes) + (Scattering angle)

= (Distance between interatomic planes) + (Scattering angle) Basically, the diffractometer has a sample container, a goniometer, and a detector to record the diffraction patterns.

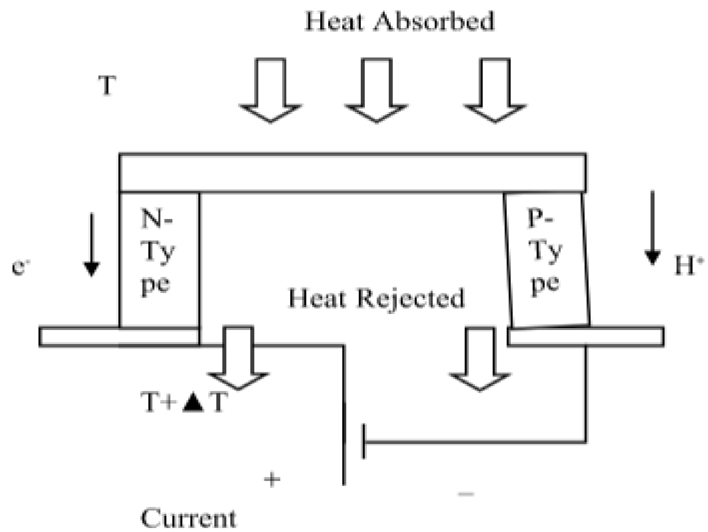


Figure l Schematic figure of Peltier effect.

To acquire every conceivable crystal lattice orientation, powdering samples is used. The goniometer may be used to determine a range of incidence angles, and a detector detects the diffraction beam intensity. An intensity vs. counter-angle (2) recording is what you get. The phases and elements contained in the sample may then be determined using these patterns. The Scherer formula [14] can be used to determine the crystallite size using XRD data. In this example, a wavelength of, a occupied girth at half maximum of the most intense peak, and a Bragg angle of. Diffraction peaks are widened when crystallinity is not ideal. The peak width analysis yields the crystallite size and lattice strain. Due to the production of polycrystalline aggregates, the crystallite size is not the same as the particle size. Coherency and stacking fault strain are also included in the strain.. A shift in the 2 peak is caused by changes in lattice strain and crystallite size, which widen the Bragg peak and increase its intensity.

**Results and Discussion.**

The morphology, phase distribution, chemical content, crystalline structure, defect presence, and crystal orientation of materials may all be examined using SEM technology. A high-energy stream of focussed electrons is used to create a variety of signals in a microscope. A certain region of the surface is covered by these signals. Processing, characteristics, and the behaviour of materials are depicted in the two-dimensional picture. Carl Zeiss Ultra 55 FE-SEM with EDAX was utilised in this study to examine the sample's morphological and nanostructural characteristics. EDAX spectra were utilized to determine the sample's fundamental composition. All of the elements contained in a sample may be discerned by comparing photon intensity with the energy of X-rays. From Z=4 onwards, all of elements in periodic table may be detected using EDAX. Qualitative and quantitative analysis are used to identify components and determine the concentration of elements in samples. The X-ray Photoelectron spectroscopy (XPS)-core level spectra were determined using an Axis Ultra DLD Kratos XPS system with a MgK source and an excitation energy of 1253.688eV. XPS spectra may be used to identify the material elemental makeup, as well as its electrical and chemical state. The photoelectric effect is at the heart of this technique, which uses X-rays to make photoelectrons t hat are detected by an electron spectrometer. There is a graph showing how many electrons are present in relation to the binding energy. All elements have the same XPS peak patterns based on their atomic weights, which correlate to their B.E. By fitting each peak with the XPS–PEAKFIT 41 programme, we can determine the oxidation state of the elements directly from these measurements. Gaussian/Lorentizian peak shape and Shirley background removal are used to match the peaks to the data. Calibration is performed using C-1s at 285eV, with a B.E value error of 0.1eV.

**Conclusion.**

An sophisticated nanoparticle analysis tool called ZetaPALS is available. When it comes to determining zeta potential, Phase Analysis Light Scattering outperforms typical light scattering methods 1,000-fold. A polar solvent, such as water, is used to conduct the tests. BIC (Brookhaven) particle size analysis software is used to analyse the intensity vs. diameter plot. As a result, the grain effective diameter may be determined. Piezoelectric and ferroelectric materials may be analysed using AC impedance measurements, which are non-destructive. The resistance to the flow of alternating current (AC) is measured by the impedance (Z). Ceramic oxide microstructures and electrical characteristics are characterized using a sophisticated impedance spectrum study. The grain boundary, grain and grain-electrode effects are shown as semicircles in the impedance plot. Higher frequency arcs show bulk qualities, and lower frequency arcs represent grain boundaries.

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