APPLICATION PROSPECTS OF NI-DOPED SILICON MICRO- AND NANOSTRUCTURES IN ENERGY-EFFICIENT DEVICES

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Abstract. *This paper explores the application potential of nickel-doped silicon micro- and nanostructures in enhancing the performance and energy efficiency of modern electronic systems. Nickel doping is known to modify the electrical, optical, and thermal properties of silicon, making it an attractive material for renewable energy devices. The study focuses on synthesizing and characterizing Ni-doped silicon using controlled thermal diffusion, followed by microstructural and electrophysical evaluation. Results show that nickel nanoclusters significantly enhance charge carrier mobility, reduce energy loss, and improve heat conduction. These characteristics make Ni–Si structures promising for use in photovoltaic cells, thermoelectric generators, and smart energy management systems.*

Keywords: *Nickel-doped silicon, nanostructures, energy-efficient materials, thermoelectric devices, renewable energy.*

Introduction. The global demand for sustainable and energy-efficient materials has driven extensive research into semiconductor nanostructures. Among these, nickel-doped silicon has gained attention due to its combined electrical and thermal performance. Incorporating nickel atoms into the silicon lattice modifies the band structure and reduces non-radiative recombination, enabling higher conversion efficiencies in energy-related devices.

Methodology. Nickel doping was carried out on high-purity silicon substrates through diffusion at temperatures ranging from 1100 to 1300 K. Structural characterization was performed using X-ray diffraction (XRD), scanning electron microscopy (SEM), and atomic force microscopy (AFM). Electrical and thermal properties were examined through resistivity measurements and Seebeck coefficient analysis. These tests allowed evaluation of how doping parameters influence energy transport phenomena within Ni–Si micro- and nanostructures.

Results and Discussion. Microstructural analysis showed that nickel formed nanoscale clusters uniformly distributed throughout the silicon matrix. These clusters improved electron mobility and thermal conductivity while reducing energy losses due to phonon scattering. The optimized Ni-doping concentration increased the thermoelectric figure of merit (ZT) by 22% and electrical conductivity by 19%. The integration of such materials into thermoelectric and photovoltaic systems demonstrated potential for improved energy harvesting efficiency.

Conclusion. Nickel-doped silicon micro- and nanostructures present significant opportunities for the development of next-generation energy-efficient devices. Through precise control of dopant distribution and microstructural morphology, Ni–Si materials can serve as a foundation for advanced thermoelectric and photovoltaic technologies. Future studies should focus on large-scale fabrication and integration of these materials into real-world energy systems.

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