Table 1: Comparison of Methodologies in Studies on ZnO Nanowires (and ZnO-related)

| Study | Year | Material System | Methodology | Limitations | Future Direction |
|---|---|---|---|---|---|
| Niloy Goswami et al. [7] | 2025 | Ge, GaN, ZnO NWs | FEM (Poisson–Schrödinger, COMSOL) | Idealized cylinders, no defects | Experimental FO & external field effects |
| T. Movla-rooy et al. [6] | 2018 | ZnO NWs | DFT + pseudopotential (NWs/NTs) | No temperature effects | Device-level modeling & experiments |
| Marco Carofiglio et al. [19] | 2020 | ZnO (NWs / nanopar-ticles) | Review of experimental & synthesis approaches | Stability in biological fluids, cytotoxicity, lack of in vivo studies | In vivo/clinical studies; optimize doping strategies |
| Wenjie Liang et al. [37] | 2009 | ZnO NWs (Co-doped) | Electrical magnetotransport | Limited scope; no secondary phases | Vary doping; higher fields for spintronics |
| Ponka J. Mokgolo et al. [21] | 2025 | ZnO (for PSCs) | Review of RE-doped ZnO in PSCs | Toxicity, scalability, cost | Better doping methods; stability in large-scale PSCs |

Table 2: Comparison of Methodologies in Studies on Silicon Nanowires (Si NWs)

| **Study** | **Year** | **Material System** | **Methodology** | **Limitations** | **Future Direction** |
|---|---|---|---|---|---|
| Noor S. Mohammad et al. [24] | 2014 | Si NWs | Comparative theory–experiment analysis | Data scatter reduces precision | Standardized QC protocols |
| Zhigang Wu et al. [17] | 2008 | Si NWs | DFT (tapered vs. straight NWs) | Purely theoretical | Experimental validation & material expansion |
| Yun Zheng et al. [22] | 2005 | Si NWs | 3D Hamiltonian discretization | Mostly simulations | Strengthen experimental verification |
| P. R. Bandaru et al. [27] | 2010 | Si NWs | Review: fabrication & properties | Surface passivation & contact issues | Nanoelectronics thermoelectrics exploration |
| Riccardo Rurali et al. [23] | 2019 | Si NWs | Review: models & simulations | Lacks experimental support | Bridge theory–experiment gap |
| A. T. Tilke et al. [25] | 2003 | Si NWs | Low-T quantum transport/interference | Very small/low-T wires | Quantum device applications |
| Zhaohui Zhong et al. [26] | 2004 | Si NWs | Low-T transport & Coulomb blockade | Device/defect complexity | Optimize for nanoelectronics QC |
| N. Fukata et al. [38] | 2005 | Si NWs | Diameter variation; thermal oxidation | Need optimized phonon confinement control | Refine synthesis for precise phonon behavior |
| Mohammad Montazeri et al. [39] | 2011 | Si NWs | Photomodulated Rayleigh scattering | Laser spot misalignment risk | Extend to other NWs & time-domain studies |
| M. L. Ciurea et al. [40] | 2005 | Si (nanocrystalline) | Energy levels & activation energy shifts | Introductory confinement study | More on confinement across nanostructures |
| A. A. Leonardi et al. [28] | 2021 | Si NWs | Critical review of MACE | Limited alignment control | Enhanced MACE techniques |
| Giovanni Pennelli et al. [5] | 2021 | Si NWs | Thermoelectric performance analysis | Fabrication scalability | Engineer NWs for improved TE performance |

Table 3: Comparison of Methodologies in Studies on Si/Ge Nanowires and Related Heterostructures

| **Study** | **Year** | **Material System** | **Methodology** | **Limitations** | **Future Direction** |
|---|---|---|---|---|---|
| E. G. Barbagiovanni et al. [4] | 2012 | Si & Ge NWs | Perturbative EMA (classification) | Neglects phonon effects | Extend to other semiconductors/defects |
| Xihong Peng et al. [15] | 2011 | Si/Ge NWs | DFT simulations | Theory-focused | Investigate larger NW diameters |
| Xihong Peng et al. [41] | 2011 | Si/Ge NWs | DFT/ab initio | High computational cost | Expand pressure studies on core–shell systems |
| Michele Amato et al. [29] | 2009 | SiGe NWs | Computational study (composition/geometry) | No experimental validation | Experimental confirmation; explore compositions |
| Ghada Badawy et al. [12] | 2024 | InAs, InSb, Ge/Si NWs | Review: synthesis & transport | Focused on III–V/IV only | Extend to other materials; topological QC |
| Ge, J et al. [42] | 2022 | Si/Ge core–shell NWs | (Not specified) | Temp. & magnetic field enhance effects | Real-world validation; refined modeling |
| Peng, X et al. [15] | 2011 | Si/Ge core–shell NWs | Uniaxial strain on varying diameters | Properties enhanced by strain | Device-level applications |
| E. G. Barbagiovanni et al. [4] | 2012 | Si & Ge NTs | EMA + perturbation theory | Size uncertainty in samples | Surface-state impact on confinement |
| Laura Loaiza et al. [30] | 2020 | Si & Ge (anodes) | Review: alloying mechanisms & strategies | Volume change, cracking, unstable SEI, Na/K kinetics | Zintl phases; cycling stability; high-rate capability |
| You Li et al. [31] | 2021 | Si & SiGe NWs | Review of fabrication techniques. | Bulk Si has high thermal conductivity. | integrating with CMOS |
| Jacopo et al. [43] | 2020 | Ge/Si | Quantum dot solar cell fabrication | Low efficiency and high defect density in the QDs | Further optimization of quantum dot |

Table 4: Comparison of Methodologies in Studies on Ge/GeSn,Si and Si/SiGe NWs

| **Study** | **Year** | **Material System** | **Methodology** | **Limitations** | **Future Direction** |
|---|---|---|---|---|---|
| S. Assali et al. [32] | 2017 | Ge/GeSn core/shell NWs | Fabrication & characterization | Strain-induced structural defects | Scale-up GeSn NW production |
| Yuanhao Miao et al. [33] | 2021 | Si-based GeSn (CVD) | Review: CVD growth & optoelectronic applications | Stability; Sn incorporation | Optimize CVD for GeSn/related |
| Luis Fonseca et al. [34] | 2021 | Si/SiGe NWs | TE devices via CVD–VLS | Doping & material stability | Scale SiGe NWs for TE devices |

Table 5: Comparison of Methodologies in Studies on GaN and Related III–N Systems

| **Study** | **Year** | **Material System** | **Methodology** | **Limitations** | **Future Direction** |
|---|---|---|---|---|---|
| Niloy Goswami et al. [7] | 2025 | Ge, GaN, ZnO NWs | FEM (Poisson–Schrödinger, COMSOL) | Idealized cylinders, no defects | Experimental FO & external field effects |
| Damien J. Carter et al. [8] | 2009 | GaN | Ab initio DFT (GGA) | Surface effects neglected | Study surface effects; experimental validation |
| Matt Law et al. [35] | 2004 | GaN NWs/NTs | Review: synthesis & optical properties | Introductory scope | Explore new nanowire applications |
| E. L. Luna et al. [9] | 2024 | GaN, InN, alloys | Review of experimental studies | Theory focus in parts | Toward improved GaN devices |