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Silver Nanoplates: Synthesis, Functional Applications and Translation Potential, A Systematic Literature Review

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ABSTRACT

Silver nanoplates and related triangular nanoprisms provide edge- and tip-enhanced plasmonics that are attractive for sensing, catalysis, energy conversion, and biomedical concepts, yet translation is frequently limited by oxidative reshaping, ligand loss, and inconsistent reporting. This systematic literature review synthesizes peer-reviewed journal evidence published between 2015 and 2025 to clarify synthesis levers, structure-property-performance relationships, and application readiness. ScienceDirect and Google Scholar were searched (last update: 15 December 2025) and screened using a PRISMA 2020 workflow and PICOC framing. From 137 records, 23 studies met inclusion criteria for qualitative synthesis. Across the literature, reproducible performance most strongly tracks coupled control of lateral size and thickness via pH, chelators, and capping ligands, which tunes LSPR position and linewidth. Applications are most mature in plasmonic sensing, including rapid pathogen and small-molecule detection, while flow-compatible catalysis and device-integrated energy studies provide clearer pathways toward deployment. Key gaps remain in standardized morphology descriptors, long-term stability protocols, batch reproducibility, and leaching or toxicity evidence. Actionable guidance is provided for scalable synthesis, robust validation, and translation-focused reporting. Unlike earlier reviews that emphasize either plasmonic principles or single application niches, this review integrates synthesis control with stability and reporting standards to accelerate translation.

INTRODUCTION

Silver nanostructures remain central to plasmonic technologies because their optical response and surface activity can be tuned far more aggressively than bulk silver. Within this family, silver nanoplates and closely related triangular nanoprisms are particularly attractive because their anisotropic geometry concentrates electromagnetic fields at edges and tips, while thickness and lateral size offer a practical route to tune LSPR over a wide spectral range. This shape driven tunability underpins many high impact uses, especially when the device function depends on strong near-field enhancement or a pronounced spectral shift (Zhang et al., 2017; Otsuki et al., 2021).

Progress in synthesis has shifted the field from simply producing nanoplates to controlling them with better predictability and yield. Mechanistic studies have clarified how growth and reshaping can evolve from nanoscale plates to much larger two-dimensional plasmonic platforms, helping connect process variables to optical outcomes (Zhang et al., 2017). More recent work has

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demonstrated tighter dimensional control using parameter sets such as pH and coordinating additives, which directly translate into more reproducible optical properties (Fernandez-Lodeiro et al., 2025). At the same time, scale has become a visible theme, with gram-quantity syntheses and continuous-flow production routes reported as steps toward manufacturable nanoplate supplies rather than one-off laboratory batches (Mravljak & Podgornik, 2023; Hu et al., 2025). Large-scale, size-controllable nanoplates have also been linked to practical aqueous detection tasks, showing that scale-up and application design are increasingly being discussed together (Zhao et al., 2017).

Applications of silver nanoplates are most mature in sensing and plasmonics, where LSPR and surface-enhanced effects can be converted into measurable analytical signals. Ordered nanotriangle arrays have been used for rapid virus detection, illustrating how architecture and morphology jointly influence sensitivity and response time in real diagnostic scenarios (Yang et al., 2022). Beyond biomedical targets, nanoplate or nanocrystal plasmonic platforms have been applied to quantify water content in ethanol mixtures, and nanoprism-based colorimetry has been developed for precise dissolved oxygen detection, reflecting the flexibility of plasmonic readouts across chemical environments (Wijaya et al., 2018; Zuo et al., 2020). However, performance can be inseparable from nanoplate stability, since chemical environments can drive reshaping or damp LSPR intensity, which ultimately affects signal reliability (Wijaya et al., 2017).

Translation potential becomes the main bottleneck when silver nanoplates leave ideal lab conditions and face oxidants, salts, heating, or complex matrices that accelerate transformation or trigger silver release. In solar-thermal nanofluids, for example, thermal performance must be evaluated together with physicochemical stability under irradiation and cycling, not only initial optical absorption (Kimpton et al., 2020). In antimicrobial design, shape-controlled triangular nanoplates prepared in gelatin–chitosan systems link morphology to antibacterial outcomes, but also raise practical questions about durability and safe deployment in realistic media (Vo et al., 2019). Across these domains, reporting practices are still uneven, with inconsistent morphology descriptors, non-uniform metrics, and limited stability or safety evidence, which makes cross-study comparison difficult and slows the extraction of transferable design rules (Otsuki et al., 2021; Wijaya et al., 2017).

Against this background, a systematic synthesis is needed to consolidate what is known and to separate robust design patterns from context-specific claims. The review addresses the following questions: the primary research question asks how silver nanoplates have been applied across major domains and which structure–property–performance relationships most strongly govern effectiveness (Zhang et al., 2017; Otsuki et al., 2021), while the secondary questions examine dominant application areas and their evolution (Yang et al., 2022), the most-used synthesis routes and control parameters (Fernandez-Lodeiro et al., 2025; Mravljak & Podgornik, 2023; Hu et al., 2025), the role of surface chemistry in performance (Wijaya et al., 2018; Zuo et al., 2020), gaps in characterization and reporting that affect reproducibility (Otsuki et al., 2021), stability and durability under relevant conditions (Wijaya et al., 2017; Kimpton et al., 2020), and safety-related evidence including leaching or toxicity where reported (Vo et al., 2019). Therefore, this systematic literature review aims to consolidate synthesis-to-application evidence for silver nanoplates and to define actionable guidance for performance, stability, and translation potential. Compared with earlier reviews that often focus on either synthesis mechanisms or plasmonic sensing performance in isolation, this review connects synthesis-control parameters to application-level outcome metrics and discusses translation readiness, providing an end-to-end, comparability-driven perspective.

RESEARCH METHODS

Review Design and Framework

This study employed a systematic literature review design and was reported following the PRISMA 2020 approach to ensure transparent identification, screening, eligibility assessment, and inclusion of studies (Page et al., 2021). The review scope and search terms were operationalized

using the PICOC framework, where the population was defined as silver nanoplates (including platelet-like Ag nanoprisms or nanotriangles when the morphology was equivalent), and the context covered functional applications and translation-relevant settings such as stability, reproducibility, scalability, and device or real-sample integration. Due to heterogeneity in reported endpoints and test conditions, results were synthesized using structured narrative and thematic approaches supported by mapping and descriptive statistics.

Eligibility Criteria and Study Grouping

Eligibility criteria were defined a priori. Only peer-reviewed journal research articles in English published between 2015 and 2025 were considered. Studies were included if they reported silver nanoplates (or equivalent platelet-like anisotropic Ag structures) with at least one of the following: synthesis or shape control, functionalization or surface chemistry, application performance, or translation-related evidence (e.g., stability or oxidation resistance, scalability, reproducibility, real-sample validation, or device integration). Conference proceedings, theses, patents, book chapters, and review papers were excluded from the evidence base, while review papers were consulted only to support background understanding. Included studies were grouped by synthesis strategy (batch or seed-mediated, additive or ligand-mediated control, biopolymer-assisted routes, and scale-up or continuous-flow production) and by application domain (plasmonic sensing/SERS/LSPR, photothermal or solar absorption, antimicrobial/biomedical use, and catalytic or redox-related functions), with an additional tag for translation readiness indicators.

Information Sources and Search Strategy

Literature searches were conducted in ScienceDirect and supplemented with Google Scholar to broaden coverage across publishers. The final search date for both sources was December 15, 2025. ScienceDirect searches were executed in Title, Abstract, and Keywords using platform-compatible Boolean strings without wildcards and with limited Boolean connectors, then refined using year, language, and document-type filters to retain only research articles within 2015–2025. Google Scholar queries combined nanoplate synonyms (e.g., “silver nanoplate”, “Ag nanoplate”, “silver nanoprism”, “silver nanotriangle”) with synthesis, functionalization, application, stability, and translation keywords, applying the same year window restriction. ScienceDirect results were exported in RIS format, while Google Scholar records were documented in a screening log to maintain traceability.

Study Selection Process and PRISMA Workflow

All retrieved records were merged and deduplicated prior to screening using DOI matching and normalized title comparison, followed by manual verification for near-duplicates. Study selection proceeded in two stages: title and abstract screening, followed by full-text eligibility assessment. Two reviewers screened records independently whenever feasible, and disagreements were resolved through discussion until consensus. For full-text exclusions, a primary exclusion reason was recorded consistently to support PRISMA reporting.

Data Collection and Extracted Outcomes

Data were extracted using a standardized form capturing material descriptors, synthesis conditions, characterization evidence, application outcomes, and translation-related variables. Extracted nanomaterial descriptors included morphology confirmation (SEM/TEM where available), lateral size, thickness or aspect ratio when reported, and optical characteristics such as LSPR peak position. Synthesis data included precursor system, reductants, capping or shape-directing agents, pH, temperature, reaction time, seed-mediated steps, and reported scale (batch volume, gram-scale, or flow). Application outcomes were captured as domain-specific performance metrics, including sensitivity or limit of detection for sensing, plasmonic response indicators for LSPR/SERS platforms, thermal performance and cycling stability for solar/photothermal systems, antibacterial efficacy measures for antimicrobial studies, and conversion or rate indicators for catalytic or redox-related uses. When numerical values or experimental conditions were missing or ambiguous, the information was recorded as not reported rather than inferred.

Risk of Bias, Effect Size, and Evidence Synthesis

Risk of bias and study quality were assessed using a reproducibility-oriented rubric tailored for experimental nanomaterials research, focusing on transparency of synthesis and characterization, adequacy of controls, clarity of test conditions, replication or variability reporting, and whether stability or safety claims were supported by data. A quantitative meta-analysis was considered only for subsets of studies reporting comparable outcomes with compatible definitions and measurement protocols; where applicable, continuous outcomes would be summarized using mean difference (or standardized mean difference) and dichotomous outcomes using risk ratio. However, given variability in morphology definitions, surface chemistry, test matrices, and endpoints across nanoplate studies, the primary synthesis used narrative and thematic integration supported by synthesis–property–application mapping and descriptive trends. Reporting bias was checked qualitatively by comparing study claims with whether corresponding outcomes (e.g., stability, reproducibility, real-sample performance) were actually reported and evidenced. Certainty of evidence was judged across themes using consistency, directness to the review scope, transparency of reporting, and reproducibility signals, producing a practical confidence level per major conclusion.

RESULTS AND DISCUSSION

Study selection and PRISMA flow

The systematic search retrieved 137 records in total, comprising 125 records from ScienceDirect and 12 records from a complementary Google Scholar search. After deduplication of the exported records (60 duplicates removed), 77 unique records were screened at the title and abstract level. Fifty-two records were excluded at this stage, mainly because they focused on spherical Ag nanoparticles, did not involve platelet or prism morphologies, or did not report an application-relevant outcome. Full texts were then assessed for 25 records. Two full-text articles were excluded with reasons, resulting in 23 included studies for qualitative synthesis.

Two “near-miss” examples illustrate the boundary of the eligibility criteria. First, an optical-response study published as a proceedings-type outlet was excluded despite relevance to plasmonic behavior because proceedings were not included in the primary evidence base. Second, review-oriented papers on triangular nanoprisms were retained strictly as background and were not counted in the PRISMA included set, consistent with the protocol (reviews used for contextual framing, not evidence synthesis).

Characteristics of the included studies and thematic distribution

Across the 23 included studies (2015 to 2025), the evidence base is dominated by two intersecting directions: (i) synthesis and shape-control routes that stabilize anisotropic Ag platelets (nanoplates, nanoprisms, nanotriangles), and (ii) application-facing demonstrations where edge and corner-enhanced plasmonics are leveraged for signal amplification, energy conversion, or catalytic coupling. A smaller but important subset explicitly addresses translation constraints such as scale-up, batch-to-batch reproducibility, real-matrix validation, and durability against oxidative reshaping.

From an application standpoint, sensing and diagnostics are the most frequent endpoints, spanning LSPR sensors, SERS platforms, and colorimetric assays. For example, a silver nanotriangle array LSPR platform was demonstrated for rapid coronavirus-related detection, including low detection limits for both viral particle proxies and protein targets (Yang et al., 2022). Similarly, nanoplate transformation was exploited as a readable signal transduction mechanism in an insecticide assay, achieving a reported limit of detection of 0.1 ppm for DDVP with real-sample recovery ranges near 90% to 107% (Khampieng et al., 2024).

On the synthesis side, multiple studies converge on the idea that platelet thickness and lateral size must be controlled simultaneously to obtain narrow plasmonic bands and stable dispersions. Ligand mediation and chemical environment (pH, chelators, and amines) repeatedly appear as practical levers to tune growth kinetics and suppress competing morphologies, reflecting a consistent mechanistic theme: stabilizing selected facets while managing oxidative etching and

corner rounding. One translation-oriented contribution reports continuous-flow, ultrasonic-assisted production at gram-per-hour scale, representing a rare move beyond bench-top batch synthesis (Hu et al., 2025).

The included studies covered synthesis control, functional applications, and translation-oriented evidence across sensing, catalysis, energy, and biomedical themes. To support transparency and allow cross-study comparison, the key characteristics of each included study, including nanoplate type, principal synthesis or engineering lever, application domain, primary outcome metrics, and translation indicators, are summarized in Table 1.

Tabel 1. Characteristics of included journal articles on silver nanoplates across synthesis and functional applications (Google Scholar and ScienceDirect, 2015–2025)

Writer	Nanostructure focus	Key synthesis / engineering lever	Application domain	Primary outcome metric(s) reported	Translation evidence
Zhao et al. (2015)	Size-tunable Ag nanoplates	Large-scale wet-chemical synthesis; size control	Chemical sensing (oxidants)	Sensitivity and detection limit for strong oxidants in water	Aqueous testing; emphasis on practical detection in solution
Wijaya et al. (2017)	Triangular Ag nanoplates	One-pot green synthesis; ligand coordination control	Stability and plasmonic sensing	Chemical stability trends; sensing response vs environment	Explicit stability discussion as a barrier to application
Zhang, X.-Y. et al. (2017)	2D Ag nanoplate plasmonic platform (25 nm to 40 μm)	Growth mechanism study; in situ optical investigation	Plasmonics (platform engineering)	Tunable optical response; morphology evolution	Scale span (nm to μm) supports translation to large-area platforms
Shahzad et al. (2018)	Hierarchical 2D silver sheets (fractal network)	Oriented attachment at low temperature	Structured plasmonic materials	Structural hierarchy; crystallinity; optical behavior	Materials design relevance; implied scalability via solution route
Wijaya et al. (2018)	Ag nanocrystal sensing platform	Nanocrystal-based optical sensing strategy	Chemical sensing (water in ethanol)	Quantification range; sensitivity in mixed solvents	Realistic matrix (water–ethanol mixtures) supports applied sensing
Yang, J. et al. (2019)	Ag–Pd triangular nanoplates	Galvanic replacement control; tuning Pd amount	Catalysis with operando SERS	SERS monitoring capability; catalytic conversion behavior	Mechanistic monitoring supports practical catalyst screening
Zhang, Z. et al. (2019)	Triangular Ag nanoprisms	Initial pH control (NaOH-pentanol); reproducible one-pot	Scalable synthesis enabling applications	Size range achieved; reproducibility and yield signals	Large-scale growth claim; process robustness emphasized
Vo et al. (2019)	Triangular Ag nanoplates	Gelatin–chitosan mediated shape control	Antibacterial	Antibacterial activity vs shape	Bio-relevance via antibacterial endpoint; material–function link
Kimpton et al. (2020)	Ag nanoprism nanofluids	Nanofluid formulation; stability under thermal loading	Solar thermal (direct absorption)	Thermal performance; physicochemical stability	Stability under operation conditions supports deployment argument
Zuo et al. (2020)	Ag nanoprisms	Colorimetric amplification strategy	Environmental sensing (dissolved oxygen)	Detection limit and linear range (DO)	Water-related metric; rapid readout supports applied monitoring
Phengdaam et al. (2021)	Mixed Ag nanoprisms	Incorporation into device stack (plasmonic excitations)	Energy device (organic solar cells)	PCE improvement and optical enhancement	Direct device integration and performance gain
Yang, Y. et al. (2022)	Silver nanotriangle array	Array-based LSPR architecture	Biosensing (coronavirus)	Response signal and detection performance	Rapid detection framing; device-like configuration (array sensor)

Writer	Nanostructure focus	Key synthesis / engineering lever	Application domain	Primary outcome metric(s) reported	Translation evidence
Mondal et al. (2022)	Ag triangular nanoprism (theranostic probe)	Computational electromagnetic / plasmonic analysis	Biomed imaging + photothermal	Predicted optical behavior; photothermal performance indicators	Translation framed as in situ imaging/PTT feasibility (model-based)
Li, J. et al. (2022)	Plate-shaped Ag particles	Monodispersed synthesis; geometry control (low R/T)	Electronic materials (conductive fillers)	Tap density; radius–thickness ratio; morphology uniformity	Manufacturing-relevant metrics (packing/tap density)
Mravljak et al. (2022)	Ag nanoplates on porous monolith	Deposition on polyHIPE; flow-through reactor design	Catalysis (flow reduction of 4-nitrophenol)	Conversion under flow; permeability retention; stability	Continuous reactor operation; durability under elution conditions
Geng et al. (2023)	Ag nanospheres → triangular nanoplates	Photoinduced transformation route	Shape-controlled plasmonics	Conversion/shape evolution; optical shift	Simple stimulus route suggests scalable post-synthesis tuning
Mravljak & Podgornik (2023)	Ag nanoplates (gram-scale)	Seedless, few reagents; storage-friendly formulation	Scalable synthesis for applications	Gram-quantity yield; concentration; storage stability	Explicit scale-up and long-term storage readiness
Khampieng et al. (2024)	Ag nanoplates (transformation -based readout)	Bi-enzyme cascade coupled with nanoplate transformation	Biosensing (insecticide)	Detection limit; response time	Rapid assay framing; practical detection time window
Pebdeni et al. (2024)	Ag/Pt nanoplates (bimetallic)	Pt coating; aptamer functionalization	Biosensing (E. coli in water)	Selectivity; sensitivity; detection performance	Water-sample relevance; platform described as applicable biosensor
Azimi et al. (2025)	Ag nanoprism (plasmonic patterning)	Plasmonic pattern reinforcement (TMB/H2O2) + DNA-based scheme	Pathogen identification (A. baumannii)	Classification/identification performance; diagnostic indicators	Translation orientation toward microbial ID; DOI provided by user
Bhardwaj et al. (2025)	Surface-alloyed AgPt nanoprisms	Pt incorporation; plasmon-mediated catalysis design	Photocatalysis (CO2 hydrogenation)	Yield/selectivity; apparent quantum yield	Energy translation framing; performance under visible light
Fernandez-Lodeiro et al. (2025)	Ag nanoplates (dimension tuning)	pH + EDTA + AMP mediated synthesis control	Optical tuning for applications	LSPR position/linewidth vs dimensions	Reproducible optical tailoring; supports application-specific design
Hu et al. (2025)	Ag nanoplates (continuous-flow)	Ultrasonic-assisted continuous-flow synthesis	Scalable production (manufacturing)	Throughput; size controllability; production stability	Explicit production scale-up pathway (continuous process)

Source: Authors' synthesis from included primary studies (2015–2025).

Risk of bias within studies and reporting limitations

Risk-of-bias appraisal indicates that internal validity is generally strongest where studies provide (i) multi-technique characterization (at least TEM or SEM plus UV–Vis, and ideally XRD), (ii) controlled comparisons against morphology or composition baselines, and (iii) replicated performance metrics with clearly described operating conditions. The most common sources of bias are performance optimism from single-batch demonstrations, incomplete reporting of variance (for example, reporting one "best" calibration curve without independent repeats), and selective emphasis on one application metric without long-term stability tracking.

A practical concern across the sensing literature is matrix-driven bias: some studies validate in buffered systems but do not confirm robustness in complex media (environmental water, food matrices, or biological fluids). Where real samples are included, recovery testing improves confidence but still does not fully address device-level variation, storage stability, and inter-user reproducibility. Publication bias was not quantitatively assessed via funnel plots because heterogeneity in endpoints (LOD, rate constants, photothermal indicators, device metrics) makes

meta-analytic aggregation methodologically weak for this dataset; therefore, synthesis is narrative and effect-size reporting is descriptive rather than pooled.

Individual study outcomes and effect-size descriptors

Given the heterogeneity of applications, effect sizes were extracted using application-relevant metrics. In sensing, the primary extracted effect size is the reported limit of detection (LOD) or sensitivity slope; in catalysis, rate constants or conversion metrics were extracted; in energy-related works, device performance improvements or absorption efficiency indicators were used when reported.

In diagnostics-oriented plasmonics, Yang et al. (2022) reported LOD values in the sub-nanomolar to picomolar regime for protein targets, and PFU-per-mL scale thresholds for viral detection proxies, consistent with strong localized field enhancement at triangle edges and tips. In transformation-based assays, Khampieng et al. (2024) showed that nanoplate reshaping can function as a built-in "readout amplifier," where morphology change replaces conventional dye amplification, achieving 0.1 ppm DDVP detection and maintaining acceptable recoveries in vegetable extracts.

For catalytic process intensification, the tubular polyHIPE reactor study demonstrates how immobilization and reactor architecture can shift the question from "can it catalyze" to "can it catalyze under flow." The reported catalytic activity reached a kcat value of 428 min^{-1} g^{-1}, and the use of a structured support reduces aggregation-related deactivation pathways that are common in colloidal plasmonic systems (Mravljak et al., 2022).

In translation-focused synthesis, a continuous-flow ultrasonic route (Hu et al., 2025) directly addresses throughput and reproducibility, reporting gram-per-hour productivity that begins to align nanoplate manufacture with application demand rather than proof-of-concept scale. This matters because many high-performance nanoplate reports still rely on fragile batch conditions, where slight differences in dissolved oxygen, halides, or ligand aging can shift morphology distributions and cause performance drift.

Because the included studies reported heterogeneous endpoints and test conditions, effect sizes were operationalized using application-appropriate performance metrics rather than a single pooled quantitative measure. The outcome measures used to compare performance across the major application clusters and the typical reporting patterns observed in the included literature are summarized in Table 2.

Tabel 2. Mapping of outcome metrics used to compare silver nanoplates across application clusters (included studies, 2015–2025)

Application cluster	Common performance endpoints	Effect-size descriptor used in this review	Main confounders to report/track
Synthesis control and scalability	Yield, size range, monodispersity, reproducibility, storage stability, throughput	Normalized "process performance" narrative score (comparability-based; non-pooled)	Precursor purity, ligand set, pH, temperature, mixing/flow regime
Plasmonic sensing and biosensing	LOD, linear range, response time, selectivity, matrix tolerance	LOD (where available) + qualitative comparability when endpoints differ	Real sample vs buffer, interferents, optical setup, chip/array geometry
SERS-enabled monitoring	Enhancement behavior, spectral stability, time-resolved tracking, substrate durability	Relative signal-change descriptors (within-study)	Laser power, hotspot density, adsorption chemistry, substrate aging
Catalysis (batch or flow)	Conversion, selectivity, rate proxy, recyclability, leaching resistance	Best-reported catalytic metric per study (conversion/rate proxy) and stability indicator	Mass transport, catalyst loading, illumination (if photocatalysis), deactivation modes
Energy and photothermal	Solar absorption gain, thermal efficiency, device performance uplift	Relative improvement vs control (percent gain)	Optical path length, dispersion stability, device architecture
Biomedical imaging/therapy	Optical window suitability, predicted/observed photothermal indicators, targeting feasibility	Non-pooled "translation readiness" descriptors	Biological matrix complexity, dose, clearance/toxicity reporting

Source: Authors' synthesis from included primary studies (2015–2025).

Integrated discussion: what is consistent, what conflicts, and what remains weak

Three consistent patterns emerge across synthesis and application studies. First, anisotropy is the functional core: nanoplates outperform more isotropic shapes in plasmonic sensing largely because corners and edges concentrate electromagnetic fields and intensify local heating and charge dynamics. Second, chemical control is inseparable from performance: platelet thickness and edge sharpness are not cosmetic variables; they directly control LSPR spectral position, linewidth, and sensitivity, and therefore "shape control" is effectively "device tuning." Third, translation is constrained less by peak performance and more by durability and manufacturability: oxidation, reshaping, and ligand desorption remain recurring threats, especially in aqueous and reactive matrices.

Contradictions are clearest in claims of stability. Some studies report usable stability over their experimental window, while others highlight rapid degradation via oxidative rounding or sphere formation, especially under light or in the presence of oxidants. These differences are not merely "good vs bad synthesis"; they often reflect different exposure conditions, ligand shells, and storage environments, which are not always reported in sufficient detail to allow direct comparison. A second tension appears in sensing validation: low LODs are frequently reported, but device integration and calibration transferability are less commonly demonstrated, making "prospects for translation" stronger in papers that include flow systems, real samples, or scale-up demonstrations than in purely benchtop calibration studies.

Finally, the evidence is weakest where the field most needs standardization: inter-lab reproducibility, long-term aging protocols, and systematic toxicity or leaching assessments that match the intended application pathway. For biomedical-facing nanoprisms and theranostic concepts, computational or proof-of-concept demonstrations are informative but still leave an implementation gap related to in vivo fate, off-target accumulation, and clinically relevant dosing constraints.

CONCLUSION

This systematic literature review synthesized 23 peer-reviewed articles published between 2015 and 2025 to clarify how silver nanoplates and closely related triangular nanoprisms are engineered, applied, and translated. Four conclusions are most impactful for both research and applications: (1) anisotropic geometry is the dominant functional driver, where edge and corner effects strengthen plasmonic responses across LSPR, SERS-enabled monitoring, and colorimetric concepts; (2) reproducible performance most consistently depends on coupled control of lateral size and thickness, governed by ligand chemistry and environmental control such as pH and coordinating additives that tune LSPR position and linewidth; (3) the main barriers to translation are durability and manufacturability, as many studies still provide limited evidence for long-term stability, batch-to-batch reproducibility, and matrix-robust calibration; and (4) higher application readiness is most evident in reports that demonstrate scale-up routes, flow or immobilized configurations, real-sample testing, or device-level integration.

Based on these conclusions, to move beyond laboratory-scale demonstrations, practical action should prioritize alignment among synthesis control, adequate characterization, and standardized reporting via a minimal reporting set covering morphology descriptors, stability protocols, and reproducibility metrics, complemented by leaching or toxicity evidence when relevant; for theory development, mechanistic links between ligand binding, facet stabilization, and oxidative reshaping should be validated using time-resolved stability datasets rather than single end-point measurements; and further research should focus on scalable synthesis with quantified reproducibility, stability engineering in realistic matrices, and device integration studies that report inter-device variation.

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