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Editorial Note

# Editorial Note on Phosphazene-Based Antimicrobial Dental Materials: A New Frontier in Restorative Dentistry

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## INTRODUCTION

Despite their widespread use due to their aesthetic and mechanical properties, dimethacrylate-based dental restorative materials have a significant drawback: a lack of intrinsic antimicrobial activity. This makes them vulnerable to microbial colonization and the development of secondary caries.

Given the growing threat of antibiotic resistance and the adverse effects associated with traditional antimicrobial additives (such as gastrointestinal disturbances, hematological disorders, and hypersensitivity reactions), the introduction of non-toxic bioactive compounds represents an important clinical and scientific challenge. Although metal nanoparticles have been considered as an alternative, they have significant drawbacks, including uneven distribution within the polymer matrix, a tendency to aggregate (which reduces antimicrobial efficacy), and the potential for leaching from the material, potentially causing toxic effects on surrounding tissues [1].



Against this backdrop, phosphazene-based compounds are attracting increasing interest, particularly organocyclophosphazenes (OCPs), which are hybrid organo-inorganic materials characterized by chemical lability and potentially low toxicity to humans [1,2].

### Compounds for Promising Applications

OCPs are hybrid organo-inorganic materials whose chemical versatility opens up wide possibilities for their use in biomedicine. Their importance in dentistry stems from a number of key advantages. They exhibit proven antimicrobial activity against a wide range of oral pathogens, including gram-positive bacteria (B. cereus), gram-negative bacteria (K. pneumoniae), mycobacteria (M. tuberculosis), and Candida fungi [1]. Recent studies have shown that hexaallylaminocyclotriphosphazene (HAP) is a particularly effective nanomodifier for dental composites.

With a nanometer-sized particle size (approximately 1.3 nm), HAP readily copolymerizes with methacrylate resin-based matrices. The resulting modified composites not only exhibit excellent physical and mechanical properties (maximum flexural strength reaches 115 MPa with a HAP content of 5%) but also exhibit pronounced antibacterial activity against S. mutans, the main causative agent of dental caries. Furthermore, at concentrations exceeding 5%, these materials effectively inhibit the formation of biofilms on their surfaces [3].

### Clinical and Scientific Perspectives

These advances mark the emergence of a new generation of "active" dental materials. Unlike metallic nanoparticles (e.g., silver), which are highly cytotoxic and cause side effects such as argyria and argyrosis, OCPs are potentially non-toxic to humans [1]. Their unique ability to undergo chemical functionalization enables the targeted creation of specialized materials that synergistically combine long-lasting antimicrobial activity with excellent mechanical properties. In addition to dental composites, fluorinated polyphosphazenes have demonstrated the ability to effectively inhibit bacterial adhesion and biofilm formation, thereby providing control over microbial infections [4]. The introduction of fluorophenoxy groups into the polyphosphazene backbone (P-N structure) increases surface rigidity and significantly reduces staphylococcal adhesion, while simultaneously inhibiting biofilm formation for up to 28 days [4,5]. Water-resistant elastomers based on polyphosphazenes with a low degree of cross-linking and pendant trifluoroethoxy and fluoroalkoxy groups have already found commercial application in the production of microbially resistant shock-absorbing elements of dentures [6].

## CONCLUSION

Dental materials based on OCPs represent a highly promising area of research aimed at addressing the persistent clinical problem of restoration-associated oral infections. Despite these encouraging preliminary results, further in-depth studies are urgently needed to evaluate the long-term clinical efficacy of these materials, their stability under challenging oral conditions, and their comprehensive safety profile. This editorial aims to

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draw the attention of the scientific community to this emerging but highly significant area of research, which holds enormous potential for extending the lifespan of restorations and significantly improving patients' dental health.

## REFERENCES


1. Yudaev P, Tupikov A, Chistyakov E. Organocyclophosphazenes and materials based on them for pharmaceuticals and biomedicine. Biomolecules. 2025 Feb 11;15(2):262.
2. Dagdag O, Kim H. Progress in the field of cyclophosphazenes: Preparation, properties, and applications. Polymers. 2023 Dec 29;16(1):122.
3. Tamboura B, Yudaev P, Butorova I, Klyukin B, Chuev V, et al Chistyakov E. Hexaallylaminocyclotriphosphazene-modified dental compositions for 3D printing of dental crowns. Polymers. 2025 Dec 24;18(1):53.
4. Tang M, Chen C, Zhu J, Allcock HR, Siedlecki CA, et al Xu LC. Inhibition of bacterial adhesion and biofilm formation by a textured fluorinated alkoxyphosphazene surface. Bioactive Materials. 2021 Feb 1;6(2):447-59.
5. Alwine S, Chen C, Shen L, Allcock HR, Siedlecki CA,et al Xu LC. Crosslinkable fluorophenoxy-substituted poly [bis (octafluoropentoxy) phosphazene] biomaterials with improved antimicrobial effect and hemocompatibility. Journal of Biomedical Materials Research Part B: Applied Biomaterials. 2023 Aug;111(8): 1533-45.
6. Allcock HR, Chen C. Polyphosphazenes and the process of macromolecular substitution. ACS Polymers Au. 2025 Oct 9;5(6): 811.