

Egyptian Prosthodontic Association (EPA Newsletter)

Chairside Revolution: 3D Printing Hybrid Ceramics as an Alternative to Milling



Electronic Newsletter

Volume 5, Issue 4

April 2026

Introduction

The integration of chairside CAD/CAM systems has significantly transformed restorative dentistry, with subtractive manufacturing (milling) long considered the gold standard for fabricating indirect restorations. However, the emergence of additive manufacturing, particularly 3D printing of hybrid ceramic materials, has introduced a potential alternative. Hybrid ceramics, combining ceramic fillers within a polymer matrix, offer favorable mechanical properties and improved machinability.⁽¹⁾ Recent advancements in printable hybrid ceramic resins have enabled clinicians to fabricate definitive restorations chairside, reducing material waste, tool wear, and production time. This paradigm shift aligns with the broader movement toward minimally invasive, efficient, and digitally integrated workflows in prosthodontics.⁽²⁾

Material Science of 3D Printable Hybrid Ceramics

3D printable hybrid ceramics are typically composed of highly filled photopolymerizable resins incorporating ceramic particles such as silica or zirconia. These materials aim to replicate the biomechanical behavior of dentin-enamel complexes by balancing strength and elasticity. The filler content, particle distribution, and degree of conversion achieved during polymerization significantly influence the final mechanical properties.^(3,4) Compared to milled hybrid ceramics, printed counterparts may exhibit slightly lower flexural strength but demonstrate superior fracture resistance due to their more homogeneous internal structure. Post-processing protocols, including washing and post-curing, are critical in achieving optimal material performance and biocompatibility.^(1,3)



Clinical Workflow: Printing vs Milling

The chairside workflow for 3D printing hybrid ceramics differs fundamentally from milling. While milling involves subtracting material from prefabricated blocks, additive manufacturing builds restorations layer by layer from a digital design. This allows for greater design flexibility, including internal features and reduced material waste. Chairside printing workflows typically include intraoral scanning, CAD design, printing, washing, and post-curing. Although printing introduces additional post-processing steps, it eliminates bur wear and reduces dependency on inventory of different block sizes and shades. Time efficiency is becoming increasingly competitive, especially with newer high-speed printers, making same-day restorations feasible in selected cases. ^(5,6)

Mechanical Properties and Clinical Performance

Mechanical performance remains a key consideration when comparing 3D printed hybrid ceramics with milled materials. While milled hybrid ceramics benefit from industrial polymerization under controlled conditions, advancements in photopolymer chemistry and post-curing units have significantly improved the strength and wear resistance of printed materials. ^(2,7)

Studies indicate that printed hybrid ceramics exhibit adequate flexural strength and fatigue resistance for single-unit restorations, particularly in low to moderate load-bearing areas. However, long-term clinical data is still limited, and concerns remain regarding wear resistance, surface degradation, and color stability over time. ⁽⁸⁾

Advantages and Limitations

The primary advantages of chairside 3D printing of hybrid ceramics include reduced material waste, lower equipment wear, and enhanced customization capabilities. Additionally, additive manufacturing allows for batch production and efficient use of materials, which may improve cost-effectiveness over time. However, limitations include the need for strict post-processing protocols, sensitivity to printing parameters, and variability in material properties depending on printer type and settings. Furthermore, regulatory approvals and limited long-term clinical evidence may hinder widespread adoption. Operator experience also plays a critical role, particularly in optimizing print orientation, support design, and curing protocols. ^(9,10)

Available Materials and Chairside Systems

The clinical adoption of 3D printed hybrid ceramics has been accelerated by the introduction of integrated chairside systems and validated restorative materials. The **SprintRay Midas system** (figure 1) represents a major advancement, utilizing Digital Press Stereolithography (DPS) to process highly filled, ceramic-dominant resins that were previously difficult to print due to viscosity limitations. Its capsule-based workflow simplifies handling and enables fabrication of definitive restorations such as crowns and veneers in minutes, making same-visit dentistry increasingly practical.

On the material side, the **SprintRay Ceramic Crown** is among the first printable ceramic-dominant resins indicated for definitive restorations, offering high filler content and optimized esthetics for chairside use. Similarly, **Saremco Crowntec** provides a nano-hybrid composite alternative with favorable mechanical properties for crowns, inlays, and veneers. In addition, system-specific hybrid composite resins—often described as modular or “Lego-like” materials—are emerging, designed to function within closed printing ecosystems and ensure predictable performance. (figure 2)

Despite these advancements, a key limitation remains the strong coupling between materials and specific printer systems, restricting interoperability compared to milling workflows. However, this controlled integration also enhances consistency and clinical reliability, supporting the growing role of 3D printing as a chairside alternative in prosthodontics.



Figure 1: Sprinray MIDAS



Figure 2: Saremco Crowntec Permanent Printing Resin



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