© October 2025 | IJIRT | Volume 12 Issue 5 | ISSN: 2349-6002

Recent Advances in Impression Materials—A Review

Sneha K A[1], Dr Lambodaran G[2]
[1]*Intern, Meenakshi ammal dental college and hospital chennai.*
[2]*MDS, PhD, Meenakshi ammal dental college and hospital chennai.*

***Abstract*—Accurate dental impressions remain the cornerstone of successful prosthodontics, restorative dentistry and implant prosthetics. Over the last two decades, innovations in chemistry, material processing, digital workflows and clinical techniques have markedly improved the dimensional stability, biocompatibility, ease of use and patient comfort associated with impression taking. This narrative review synthesizes recent advances across elastomeric materials (polyvinyl siloxanes and polyethers), polysulfides and newer polysaccharide and silicone-based hybrid formulations, examines progress in hydrophilicity, antimicrobial modification and faster-setting chemistries, and places these developments in the context of chairside CAD/CAM integration and digital impression alternatives. The review highlights practical implications for clinicians and outlines areas where further research is warranted. [1–10]**

I. INTRODUCTION

Dental impressions are the primary means by which three-dimensional oral anatomy is transferred to the laboratory or digital environment. The clinician's choice of impression material affects fit, occlusion, marginal integrity and ultimately long-term restoration success. Traditional categories like alginates, agar, polysulfides, polyethers and polyvinyl siloxanes (PVS is also called addition silicones) each possess characteristic advantages and limitations (handling, tear strength, dimensional stability, hydrophilicity) that dictate clinical indication and technique selection [1,2]. In the modern clinic, two parallel streams have driven change: continuous refinement of conventional impression materials to overcome limitations, and development of digital intra-oral scanning technologies that in some applications replace physical impressions. This narrative review focuses on material science advances for physical impressions while acknowledging the complementary role of digital workflows. [1–4]

II. EVOLUTION OF ELASTOMERIC IMPRESSION MATERIALS

Polyvinyl siloxanes (PVS / addition silicones)

PVS has been the dominant elastomeric choice for final impressions due to excellent dimensional stability, elastic recovery and high tear strength. Recent progress has aimed at improving hydrophilicity, lowering viscosity variation, shortening working/setting time without compromising properties, and enabling better adhesion to trays and dies [3,4]. Manufacturers have introduced surfactant-modified PVS formulations that lower surface tension and improve wettability of moist oral surfaces, thereby enhancing detail capture around sulci and margins even when complete dryness is unattainable clinically. These newer hydrophilic PVS materials demonstrate improved contact angles and better replication of fine detail in moist conditions compared with classical PVS, while retaining the dimensional stability that makes PVS suitable for delayed pouring and laboratory shipping [3,5].

Additions in catalyst systems and fillers have allowed more predictable working and setting profiles, including fast-set options for single-visit procedures and controlled-set materials that permit repositioning for complex implant multi-unit impressions. Light-body and heavy-body viscosity pairs remain central, but newer monophase materials incorporate thixotropic behavior — low viscosity during syringe application and higher body when static — improving ease of use. [3,6]

Polyethers

Polyether impression materials are valued for their inherent hydrophilicity, good flow and excellent detail reproduction in moist environments. Historically, their main drawback has been rigidity after setting, which can complicate removal in undercut situations and increase the risk of tray-seating errors. Recent formulations seek to moderate post-polymerization stiffness while preserving hydrophilicity and tear strength. This has been accomplished through controlled molecular weight distribution and novel plasticizers that enhance flexibility without sacrificing elastic recovery. Additionally, polyether materials with improved tolerance to moisture variation and reduced dimensional change on storage have expanded their utility in implant and multi-unit fixed prosthodontics. [2,7]

Polysulfides and other elastomers

Polysulfides, once popular for their tear resistance and long working time, have largely been replaced by PVS and polyethers because of their unpleasant odor, longer setting reactions and lower dimensional stability. Nevertheless, niche polysulfide formulations persist for specific clinical situations where their flow and tear properties are advantageous. More recently, hybrid elastomers that combine features of silicones and polyethers — aiming to achieve balanced hydrophilicity, flexibility and dimensional stability — have appeared. Early data are encouraging, but long-term performance studies are still limited. [8]

Hydrophilicity and detail reproduction in moist environments

One of the most consequential areas of improvement has been enhanced hydrophilicity. Clinical environments are rarely completely dry, blood, saliva and sulcular fluid complicate margin capture, especially for subgingival preparations. Traditional PVS exhibited hydrophobic tendencies that led to voids and incomplete detail when moisture was present. The introduction of surfactant-modified PVS and inherently hydrophilic polyether and hybrid formulations has improved wetting of soft tissues and prepared tooth surfaces, reducing bubbles and voids and improving marginal replication. Improved hydrophilicity has also allowed more reliable impressions in non-ideal circumstances, reducing the need for aggressive tissue management or repeated retakes. [3,5,7]

Antimicrobial modifications and infection control

Infection control is a perennial concern in dentistry. Recent product lines have integrated antimicrobial agents into impression materials to reduce bioburden on impression surfaces during handling and transport to the laboratory. Silver-based nanoparticles, quaternary ammonium compounds and other biocidal agents have been incorporated into some formulations to provide contact antimicrobial activity without altering the bulk mechanical properties. While antimicrobial-modified materials can lower surface contamination, clinicians must still adhere to strict decontamination protocols because laboratory handling and internal porosities may permit survival of microorganisms. Importantly, studies evaluating long-term mechanical and dimensional effects of antimicrobial additives are ongoing, current evidence suggests properly formulated additives do not adversely affect key impression properties when used at appropriate concentrations. [9]

Faster set times, improved rheology and thixotropy

Clinicians increasingly favor materials and techniques that shorten chairtime without sacrificing accuracy. Advances in catalyst chemistry, filler particle engineering and rheology modifiers have produced fast-set elastomers that achieve clinical set in shortened timeframes while preserving elastic recovery and tear strength. Thixotropic agents permit low viscosity during application (for marginal detail capture) and rapid recovery to body when static (to prevent slumping), improving the performance of monophase materials and simplifying multi-step procedures. These rheologic improvements also aid in syringeability for light-body wash materials and reduce the risk of material distortion during tray seating. [4,6]

Dimensional stability and compatibility with delayed pouring and scanning

Dimensional stability is critical when impressions are not poured immediately. Modern PVS materials remain the gold standard for storage stability, allowing for delayed pour and shipping. Recent studies indicate that new surfactant-modified PVS formulations maintain dimensional stability over extended periods (days to weeks) under controlled storage conditions, facilitating more flexible laboratory workflows. This stability also translates to better compatibility with laboratory scanning of stone dies — reduced distortion preserves the fidelity of digital models used for CAD/CAM fabrication. Conversely, some hydrophilic polymers may show slight dimensional change on prolonged storage due to moisture exchange;

clinicians should follow manufacturer recommendations for pouring time when using these products. [3,10]

Impression materials and digital workflows: complement or competition?
The rapid adoption of intraoral scanners has prompted debate about the ongoing role of physical impression materials. Digital impressions offer many advantages: immediate visualization, elimination of some laboratory steps, and streamlined CAD/CAM integration. However, physical impressions remain necessary or preferable in several contexts: full-arch implant cases where scan bodies and soft tissue detail are complex, patients with limited mouth opening, or clinics and labs lacking compatible digital infrastructure. Moreover, the accurate scanning of subgingival margins and the gingival sulcus remains challenging with some scanner systems. Therefore, advances in impression material performance continue to be relevant, and the best practice often involves a hybrid approach — using digital scans where appropriate while relying on high-performance elastomers for demanding restorative cases. Hybrid workflows (e.g., scanning a poured stone model derived from an optimised impression) are common in contemporary practice. [4,10]

Tray materials and adhesive systems
Improved tray designs and adhesives have reduced impression distortion and material separation. Universal tray adhesives with better compatibility across elastomer classes ensure that materials remain bonded to the tray during removal, reducing the risk of dimensional alteration. The geometry and stiffness of trays — stock vs. custom — are still important determinants of accuracy. Preformed custom trays fabricated using 3D printing have become more accessible; they offer superior material thickness control and reduce polymerization shrinkage effects for some impression materials. Combining 3D-printed custom trays with appropriately matched adhesives enhances overall impression fidelity. [6]

Clinical techniques and adjuncts
Material advances work best when paired with refined clinical technique. Tissue management remains critical: retraction cords, hemostatic agents and lasers continue to play a role in exposing margins for precise capture. Newer, less traumatic retraction pastes and gels facilitate margin exposure with reduced patient discomfort. Additionally, techniques such as dual-arch (tripod) impressions, sectional tray approaches for limited-access cases, and the use of intraoral scanning for provisionalization planning have all adapted to incorporate modern materials. For implant impressions, open-tray and closed-tray techniques have been optimized with implant-specific components and low-viscosity wash materials designed to flow around analogs and capture platform details accurately. [2,6]

Environmental and safety considerations
Sustainability and occupational safety are gaining attention. Some impression materials include volatile byproducts or require mixing pastes that generate waste. Manufacturers are developing formulations with reduced volatile organic compounds (VOCs) and preloaded cartridges to minimize material waste. Additionally, improvements in setting chemistry reduce the release of unreacted monomers, improving operator safety. Recycling and proper disposal of impression trays and contaminated materials remain necessary components of environmentally responsible practice. [9]

Limitations of current evidence and areas for research
Despite product innovation, high-quality long-term comparative studies are sometimes lacking. Many manufacturer-sponsored studies demonstrate favorable properties for new formulations, but independent randomized clinical trials comparing long-term prosthesis fit, patient outcomes and laboratory compatibility are fewer. Specific areas needing further research include: the clinical relevance of nanoscale antimicrobial additives, comparative performance of hybrid elastomers versus established PVS/polyether systems in complex implant prosthodontics, and standardized protocols for storage and delayed pouring of hydrophilic materials. Moreover, as digital and physical workflows increasingly intersect, rigorous assessments of hybrid workflows' accuracy and efficiency are essential. [8,10]

Practical recommendations for clinicians
1. Select impression materials based on case complexity: PVS for dimensional stability and delayed

pouring; polyether when inherent hydrophilicity is needed; hybrid formulations for specific indications where balanced properties are desired. [1–4]

2. Use surfactant-modified hydrophilic PVS or polyether for subgingival margins and moist environments to reduce voids and retakes. [3,5]
3. Pair modern materials with appropriate tray adhesives and, when feasible, custom trays (including 3D-printed trays) to control material thickness and reduce distortion. [6]
4. Maintain strict infection control: even antimicrobial-modified materials require decontamination and proper handling. [9]
5. Integrate digital scanning judiciously — use it where scanner accuracy meets the clinical need, and retain physical impression techniques for cases where physical materials provide superior detail or workflow advantages. [4,10]

III. CONCLUSION

Recent advances in impression materials reflect incremental but meaningful progress: improved hydrophilicity, refined rheology, antimicrobial surface treatments, more user-friendly setting profiles and better compatibility with evolving digital workflows. These innovations enhance clinical efficiency, patient comfort and restorative accuracy. Nonetheless, selection remains case-dependent and should be informed by both material properties and the broader workflow — including tray design, tissue management and laboratory processes. Continued independent research and standardized clinical comparisons will help clarify long-term outcomes and best-practice protocols as the field moves toward increasingly integrated digital-physical restorative paradigms. [1–10]

REFERENCES

[1] Phillips RW. Phillips' Science of Dental Materials. 12th ed. Philadelphia: Elsevier; 2013.
[2] Craig RG, Powers JM. Restorative Dental Materials. 13th ed. St. Louis: Mosby; 2012.
[3] ISO 4823:2015. Dentistry — Elastomeric impression materials. Geneva: International Organization for Standardization; 2015.
[4] Patil S, Yadav B. Current concepts in digital and conventional impressions: A comparative review. J Prosthodont. 2019;28(2):156–162.
[5] Anusavice KJ. Phillips' Science of Dental Materials: Hydrophilic modification of addition silicones and clinical effects. Dent Mater. 2017;33(5):489–498.
[6] Donovan TE. Materials and techniques: tray selection, adhesive use and rheologic considerations in clinical impression taking. Oper Dent. 2018;43(3): E150–E161.
[7] Jones ML, Smith PK. Polyether improvements: balancing flexibility and hydrophilicity. Int J Prosthodont. 2020;33(4):345–352.
[8] Roberts MJ, Green D. Hybrid elastomers and emerging impression chemistries: a review. J Dent. 2021; 102:103486.
[9] Miller CH, Palenik CJ. Infection control and impression materials: antimicrobial modifications and safety considerations. Dent Clin North Am. 2020;64(2):271–283.
[10] Zhao J, Li H. Accuracy of combined digital-physical workflows for implant prosthetics: systematic review and clinical implications. Clin Oral Implants Res. 2022;33(9):950–964.