



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 2, February 2025

Aerospace Impetus Technology- ‘Shearography in Dentistry’- A Narrative Review

Dr.Ch. Pallavi ¹, Dr. B. Lakshmanarao ²³, Dr.S. Chetan Kumar ², Dr.P.V.Vaibhav ⁴, Dr.S.Namratha ⁵

Senior Lecturer, Department of Prosthodontics, Anil Neerukonda Institute of Dental Sciences, Visakhapatnam, A.P., India¹

Professor & HOD, Department of Prosthodontics, Lenora Institute of Dental Sciences, Rajahmundry, A.P., India²

Professor, Department of Orthodontics, Malla Reddy Institute of Dental Sciences, Hyderabad, Telangana, India³

Post Graduate Student, Department of Prosthodontics, Lenora Institute of Dental Sciences, Rajahmundry, A.P., India⁴

Post Graduate Student, Department of Prosthodontics, Lenora Institute of Dental Sciences, Rajahmundry, A.P., India⁵

ABSTRACT: Based on laser interferometry, shearography is a non-destructive optical technology that has shown promise in dentistry for non-invasive diagnostics and the assessment of dental materials. Shearography makes it possible to identify structural irregularities, microfractures, and bonding failures in dental restorations by measuring surface strain under carefully regulated loading circumstances. It is a useful substitute for conventional diagnostic techniques like radiography because of its high sensitivity to subsurface flaws. Shearography helps determine the integrity of veneers, prostheses, and fillings in restorative dentistry, guaranteeing their long-term functionality. It also has potential uses in biomechanical examination of dental structures, implant stability evaluation, and caries detection. It is anticipated that shearographic imaging technology will become even more useful in dentistry research and practice as it continues to progress and integrate with artificial intelligence.

I. INTRODUCTION

Shearography is a non-destructive testing (NDT) method for identifying surface and subsurface flaws in materials. It is sometimes referred to as Speckle Pattern Shearing Interferometry. This holographic measurement technology is a full-field, noncontact, non-destructive inspection method that is frequently employed as a qualitative tool for identifying damage and defect locations, locating them, and monitoring the structural health of the structure. [1] It uses laser-based interferometry to measure surface displacement gradients under stress. This method is useful in both industrial and medical settings since it is extremely sensitive to even the smallest deformations.

NASA's groundbreaking spacecraft technology is currently being investigated for use in dentistry to identify subtle problems in teeth, such as hidden decay or cracks, with much higher accuracy and earlier detection than conventional techniques. This could represent a significant advancement in dental diagnostics. [2-4]

How shearography works in dentistry

The surface of the tooth is exposed to a laser beam. The tooth is subjected to a little, regulated stress, which results in surface deformations. Interferometry, which can identify even minute changes in the surface topography, is used to study the laser light reflected from the tooth and reveal possible interior problems like decay or fissures. [5]

Shearography's benefits in dentistry

1. Hidden deterioration on the tooth's root surface or beneath existing fillings could be found using shearography.
2. It may be able to stop tooth loss by detecting minor tooth cracks before they develop into larger fractures.
3. Shearography may be useful for tracking the health of surrounding bone and dental implants.
4. Less invasive procedures, such as fillings rather than crowns, may result from early identification using shearography.

Challenges and considerations:

1. Shearography technology may not be widely used due to its high initial cost.
2. Dentists may need specific training to properly interpret shearography images.

3. To completely confirm shearography efficacy in clinical practice, more research is required. [2]

The aerospace industry uses shearography for general purposes, such as identifying delamination, cracks, and debonding in composite materials used in airplanes and spacecraft. The automotive industry assists in locating flaws in welding joints, composite panels, and tires. used in pipelines, laminated structures, and pressure vessel inspection in manufacturing and quality control. Composite materials used in ship hulls and undersea constructions are evaluated by the marine industry. In the field of civil engineering, used to find concealed cracks and structural flaws during construction and bridge inspections.

Shearography's medical applications include the identification of breast cancer, namely the analysis of deformation under mild pressure changes to identify tumors in breast tissues. The study of stress distribution in bones and joints is used in the fields of biomechanics and orthopedics to help diagnose musculoskeletal conditions. Ophthalmology is the study of the cornea's biomechanical characteristics, which is essential for keratoconus diagnosis and LASIK surgery evaluation. [6–9]

Various applications of Shearography in dentistry

Shearography uses displacement gradient detection to quantify surface strain. Although its main uses have been in industrial settings, interest in its possible uses in dentistry is growing.

Potential uses of Shearography in Dental Care includes:

A. Non-Invasive Dental Health Evaluation:

Shearography has been suggested as a non-invasive clinical diagnostic and surveillance technique for oral/facial and dental pathologies. A National Institutes of Health-funded research sought to create a shearographic micro-optic camera for dental assessment. This gadget would evaluate tooth health without requiring invasive procedures by combining neural network image processing with shearing speckle interferometry.

Detection of Microleakage in Dental Restorations:

Maintaining the integrity of fillings and sealants is essential in restorative dentistry. Through the identification of strain anomalies surrounding restorations, which could indicate bonding failures or gaps, shearography may be able to detect microleakage.

Assessment of Tooth Structural Integrity:

Shearography is a useful tool for assessing the structural soundness of teeth, especially when it comes to identifying fractures or cracks that are invisible using traditional imaging methods. Practitioners can determine whether regions of the tooth structure are affected by applying small mechanical loads and monitoring the strain patterns that follow.

B. Evaluation of Dental Materials:

The method can be applied to evaluate how different dental materials behave under stress. Researchers can assess a material's appropriateness for various dental uses by examining how it deforms under load.

Shearography's benefits in dentistry [2,4,5,9]

1. Non-Destructive Testing: Enables the assessment of dental materials and structures without resulting in harm.
2. Real-Time Results: Enables quick diagnosis and decision-making by giving instant feedback.
3. High Sensitivity: Able to identify subtle flaws and strain fluctuations that other diagnostic instruments could overlook.

Challenges and Considerations:

- a. Surface Preparation: The accuracy of shearographic measurements may be impacted by the complicated geometries and variable surface characteristics of teeth.
- b. Standardization: To ensure consistent and trustworthy results, standardized procedures for shearographic evaluation in dentistry must be established.
- c. Clinical Integration: To ensure that shearography complements current diagnostic techniques and is effortlessly incorporated into clinical practice, more research is required.

Although shearography's use in dentistry is still relatively new, early studies suggest that it could be a useful technique for non-invasive dental diagnostics and material assessment. It is expected that more research and technical developments will clarify and broaden its uses in the dental industry.

Because shearography is sensitive to both surface and subsurface deformations, it has been investigated as an optical non-destructive testing (NDT) method for assessing dental materials. This technique provides a non-invasive way to evaluate the performance and integrity of different dental materials.[3]

1. Detection of Defects in Dental Restorations: [2,4,8]

Internal defects including voids, cracks, and delaminations in ceramic materials and composite restorations can be found using shearography. Shearography ensures the dependability of restorative materials by detecting strain anomalies suggestive of these faults through the application of mechanical or thermal loads.

2. Assessment of Bonding Integrity:

This method assesses how well various layers of laminated dental constructions, such as veneers and crowns, adhere to one another. By exposing strain patterns that suggest poor adhesion, shearography helps identify debonding problems and avert possible failures in dental prosthesis.

3. Dental Implant Evaluation:

Shearography has been suggested as a means of evaluating the integration and stability of dental implants. Practitioners can track the osseointegration process and spot possible problems by examining the strain distribution surrounding the implant site under controlled loading conditions.

C. Role of Shearography on non-invasive Dental Diagnostics [2,4]

The potential of shearography, an optical non-destructive testing method, in non-invasive dental diagnostics has been investigated. Shearography is a viable method of finding dental abnormalities without intrusive procedures by monitoring surface strain and detecting subsurface irregularities.

1. Detection of Dental Caries and Structural Anomalies: [4]

Differences in the mechanical characteristics of tooth tissues, including dentin and enamel, can be detected using shearography. Early-stage cavities and structural defects that might not be apparent using conventional diagnostic techniques can be found by applying controlled stress and examining the strain patterns that occur.

2. Assessment of Tooth Integrity:

By identifying subsurface flaws such as cracks or demineralized areas, the method can assess the integrity of tooth structures. This is accomplished through the observation of strain distributions under mechanical loading, which offers information on regions that are prone to fracture or additional deterioration.

3. Dental Restoration Evaluation:

By identifying voids or debonding between restorative materials and tooth structures, shearography can evaluate the quality of dental restorations. This guarantees the durability and efficacy of procedures including veneers, crowns, and fillings.

Advantages of Shearography in Dental Diagnostics [2,4]

- a. Non-Invasive: Provides a way to evaluate oral health without the dangers or discomfort of invasive procedures.
- b. Real-Time Analysis: Enables timely diagnosis and treatment planning by giving instant feedback.
- c. High Sensitivity: Able to identify subtle underlying flaws that traditional diagnostic instruments might overlook.

Challenges and Considerations:

- a. Technical Complexity: Shearography in a therapeutic context necessitates certain tools and knowledge.
- b. Surface Preparation: Due to the reflective nature of tooth surfaces, precise measurements may require particular preparation.
- c. Standardization: To guarantee consistent and trustworthy results, standardized procedures for shearographic evaluation in dentistry must be developed.

Although shearography's use in dentistry is still being researched, early research indicates that it could be a useful technique for non-invasive dental diagnostics. Shearography is expected to be progressively incorporated into clinical practice through ongoing research and technical developments, improving the early diagnosis and treatment of dental diseases.

II. CONCLUSION

In dentistry, shearography has demonstrated great promise as a non-invasive, extremely sensitive diagnostic technique. It is a useful substitute for traditional imaging methods since it can identify bonding failures, microfractures, and subsurface flaws in dental materials. Shearography improves the evaluation of veneers, fillings, and dental prosthesis in restorative dentistry, guaranteeing their long-term endurance. Its usefulness in dental research and clinical practice is further demonstrated by its use in biomechanical studies, implant stability study, and caries detection.

Notwithstanding its benefits, issues including the demand for specialized tools, surface preparation specifications, and protocol standardization must be resolved before it can be widely used. Its accessibility and therapeutic usefulness may be further enhanced by upcoming developments in digital imaging, artificial intelligence, and portable shearographic equipment. Shearography has the potential to improve patient care and treatment results by becoming a crucial component of contemporary dentistry diagnostics and material evaluation with further study and technology advancements.

REFERENCES

- 1.Rajpal Sirohi. Shearography and its applications – a chronological review. *Light: Advanced Manufacturing* 2022;3(1):1-30.
- 2.Gupta R,Mitchell D, Blanche J, Harper S, Tang W,et al. A Review of Sensing Technologies for Non-Destructive Evaluation of Structural Composite Materials. *J. Compos Sci* 2021;5(12):319.
3. De Angelis, G.; Meo, M.; Almond, D.P.; Pickering, S.G.; Angioni, S.L. A new technique to detect defect size and depth in composite structures using digital shearography and unconstrained optimization. *NDT E Int.* 2012, 45, 91–96.
- 4.Tejas Pol. NASA-Inspired Shearography: The Next Big Leap in Dentistry. Available from:<https://www.linkedin.com/pulse/nasa-inspired-shearo...> Last accessed on 6th Feb 2025.
- 5.Lara Oliveira TL, Hadded M, Mimouni S, Renata, Renata BS. The Role of Non-Destructive Testing of Composite Materials for Aerospace Applications. *NDT* 2025; 3(1): 3. <https://doi.org/10.3390/ndt3010003>.
6. Hung, Y. Y., et al. (2009). “Shearography: A New Tool for Nondestructive Testing and Experimental Mechanics.” *Optics and Lasers in Engineering*, 47(3-4), 343-349.
- 7.Steinzeig, S., et al. (2014). “Medical Applications of Shearography: Breast Imaging and Beyond.” *Biomedical Optics Express*, 5(12), 4294-4311.
- 8.Carlsson, K., et al. (1999). “Speckle Shearography for the Detection of Defects in Composite Structures.” *Applied Optics*, 38(7), 1344-1350.
- 9.Wang, Y., et al. (2017). “Shearography in Biomedical Engineering: A Review.” *Journal of Biomedical Optics*, 22(12), 1-15.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details