

## Quantum Dots in Cement Composites: Unlocking Next-Generation Performance – A Review of Synthesis, Mechanisms, and Applications

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### Abstract

In recent years, there has been a substantial increase in the interest in the use of a variety of carbon based nano materials in concrete. Among these, carbon quantum dots (CQDs) and Graphene Quantum Dots (GQDs) which are subclass of CQDs have lately emerged as an innovative nanomaterial for enhancing the performance of cementitious composites. This paper provides a comprehensive review of recent research that focuses on the synthesis methods of CQDs and GQDs which are broadly classified as top down and bottom down approaches, their properties and their impact on properties of cement-based materials. The study includes the mechanism that underpins the enhancement of cement-based materials through the incorporation of CQDs and GQDs. Further the challenges associated with use of CQDs and GQDs such as dispersibility of these materials in cement composites and cost effective large scale production have been discussed. This review outlines a prospective pathway for the application of GQD and CQD technologies in the development of sustainable, durable, and intelligent building materials for future infrastructure.

