Visual simulation of opal using bond percolation through the weighted Voronoi diagram and the Ewald construction

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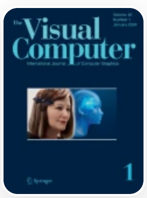

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Abstract

Opal, a renowned gemstone, exhibits an optical phenomenon known as "play of color," which is classified as a kind of structural color. This unique property makes opal a highly valuable material from the natural science, industry, and humanity perspectives. Opal has a complex internal structure called colloidal polycrystalline, and thus, representations of opal remain unestablished in computer graphics. In this study, to approximate the complex internal structure of opal, we imitate its formation process using the three-dimensional additively weighted Voronoi tessellation and percolation model. Further, we apply path tracing to compute the diffraction patterns of visible light inside opal by utilizing the Ewald construction employed in X-ray diffraction theory. Finally, we achieve a visually plausible output through spectral rendering.

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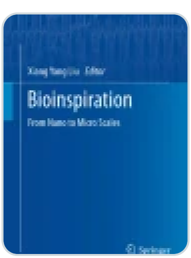

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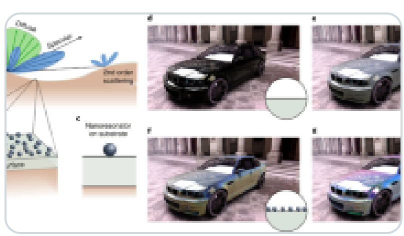

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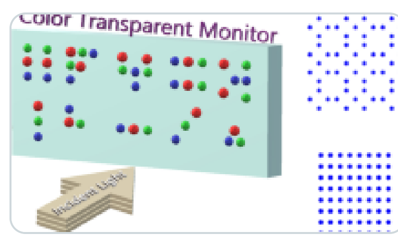

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Data availability

No datasets were generated or analyzed during the current study.

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Contributions

SY proposed the method, implemented it, and prepared the main manuscript text and figures; IF supervised the research and improved the manuscript.

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Ethics declarations

Conflict of interest

The authors declare no conflict of interest.

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