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Peer Review

Review of: "A Review on the Mechanical, Thermomechanical Properties and Crystallinity Aspects of 3D-Printed Nanocomposites Used for Fabricating Electronic/Structural Parts"

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Qeios Open Review – Constructive Report

This manuscript addresses an important and timely topic and compiles an extensive amount of data on the mechanical, thermomechanical, and crystallinity-related behavior of 3D-printed thermoplastic nanocomposites. The field continues to grow rapidly, and the effort to gather results from a wide range of studies is valuable. With further improvements in structure, synthesis, visualization, and critical interpretation, the manuscript can become a more impactful and accessible reference for researchers working on polymer nanocomposites and additive manufacturing.

Below I provide detailed, constructive suggestions organized by major sections of the manuscript.

1. Abstract

The abstract clearly introduces the motivation for studying thermoplastic nanocomposites and their relevance to additive manufacturing and sustainability.

However, it currently reads more like a general problem statement than a summary of a review paper.

It would strengthen the abstract to briefly highlight:

what categories of materials and properties were examined,

what major trends emerged from the literature, and what knowledge gaps or future research opportunities were identified.

Adding one–two sentences reflecting the *synthesized findings* of the review would improve clarity and better communicate the manuscript's contribution.

2. Introduction

The introduction provides a concise background on additive manufacturing and thermoplastic nanocomposites.

The sustainability discussion is relevant, yet the link between AM and specific SDGs could be supported with a clearer conceptual figure rather than a descriptive paragraph.

The authors may consider adding visual material such as:

a schematic connecting AM to SDG targets,

a simple comparison chart of thermoplastics vs thermosets in AM,

or a flow diagram outlining the factors affecting mechanical and thermomechanical performance.

Additionally, introducing the *scope of the review* in a more structured way (e.g., which materials, which property categories, which printing parameters) will help guide the reader through the later sections.

3. Thermomechanical Properties and Crystallinity

This section compiles a very large number of thermal and crystallinity-related findings from the literature, which is extremely useful.

To enhance clarity, the section would benefit from thematic subsections (e.g., **PLA-based systems**, **polyolefins**, **engineering polymers**, **oxide-based fillers**, **carbon-based fillers**).

Beyond listing results, the review would be strengthened by explaining *why* certain fillers increase crystallinity, Tg, or storage modulus—for example, through nucleation effects, interfacial interactions, or filler geometry.

Including a figure depicting filler-induced nucleation mechanisms or the relationship between cooling rate, crystallinity, and mechanical performance would greatly improve reader understanding.

Highlighting general trends across studies (e.g., carbon-based fillers often promote nucleation, whereas oxide fillers more strongly influence stiffness) would also increase the section's review character.

4. Tribological Properties

The tribology section touches on an interesting and practical topic; however, it currently summarizes only one study.

Expanding this part to include additional findings from ABS-, PA-, PC-, or PP-based nanocomposites would make the section more representative of the literature.

Introducing common tribological mechanisms (adhesive vs abrasive wear, transfer film formation, filler lubrication effects) could help contextualize the observed trends.

Consider presenting COF and wear-rate comparisons in a compact table along with a short interpretation of the underlying mechanisms.

5. Mechanical Properties

The manuscript presents a very extensive set of mechanical data supported by multiple tables. This is a major strength.

To enhance readability, this large section would benefit from a clearer structure such as:

Tensile properties

Flexural properties

Impact behavior

Interlaminar shear and interlayer adhesion

Grouping materials by polymer type (PLA, ABS, PA, PC, etc.) or filler type (1D/2D/3D fillers) would also allow readers to more easily navigate the information.

Adding short summaries after each subsection—highlighting shared trends, differences between matrices, or influential parameters—would help transform the text from a data collection into a synthesized review.

High-quality figures illustrating load-transfer mechanisms, filler dispersion versus agglomeration, or the influence of print orientation on mechanical anisotropy would significantly increase the explanatory power of the section.

6. Effect of Functionalization

Functionalization is an important topic, and including it as a separate section is appropriate.

Currently, the content focuses on a small number of examples.

The section could be expanded by discussing:

different functionalization approaches (amine-, carboxyl-, silane-based, polymer-grafted, etc.),

how functionalization affects interfacial bonding and load transfer,

its influence on dispersion, rheology, crystallinity, and printing behavior.

Subdividing the section (e.g., **Effect on dispersion**, **Effect on interfacial adhesion**, **Effect on tensile/toughness performance**) would help clarify the role of functionalization across different systems.

A schematic comparing functionalized vs non-functionalized filler interactions with the matrix could also be valuable.

7. Conclusions and Recommendations

The recommendations provided are relevant and actionable; however, the review would greatly benefit from a more comprehensive *conclusions* section summarizing the key trends identified in the manuscript.

It may be helpful to include:

overarching structure–property relationships observed across the studies,

general patterns in how different filler classes influence mechanical or thermal behavior,

limitations in current AM-nanocomposite research (lack of standardized testing, limited in-situ characterization, insufficient tribology studies, etc.).

A concise “future research roadmap” touching on printing parameters, in-situ monitoring, multi-scale modeling, and recycling behavior would further strengthen the closing section.

Overall Assessment

The manuscript provides a valuable and wide-ranging collection of data on 3D-printed thermoplastic nanocomposites. With improvements in organization, critical discussion, visual presentation, and synthesis of the literature, it has the potential to serve as a strong reference point for both academic researchers and practitioners.

I hope these suggestions help the authors further enhance clarity, depth, and impact in the next revision.

Additional Suggestions to Enhance Clarity, Mechanistic Insight, and Visual Understanding

To further strengthen the manuscript and increase its value as an analytical review, several constructive enhancements can be made in the areas of visualization, mechanistic explanation, and comparative interpretation.

Suggested Figures and Diagrams to Improve Visual Understanding

Adding a few schematic figures would significantly enhance the readability and conceptual clarity of the review:

Filler-Induced Nucleation Mechanisms

A simple diagram showing how polymer chains order around graphene, CNTs, or oxide nanoparticles during cooling. This would clarify why crystallinity increases for certain fillers.

Structure–Property Relationship Map

A flow diagram linking:

filler type → dispersion quality → crystallinity → mechanical/thermal/tribological properties.

This helps readers quickly grasp global trends.

Comparison of 1D, 2D, and 3D Filler Geometries

In polymer nanocomposites, CNTs are typically classified as **one-dimensional (1D) fillers**, graphene as **two-dimensional (2D)**, and silica/titania/alumina as **three-dimensional (3D)** particulate fillers.

A schematic comparing their geometries and expected effects (stiffness, anisotropy, toughness) would be very helpful.

Tribological Mechanism Illustration

A schematic explaining adhesive vs. abrasive wear and why carbon-based fillers reduce COF by forming a lubricative transfer layer.

Improved Internal Architecture/Voids Visualization

Higher-resolution, clearly labeled graphics explaining infill geometry, interlayer voids, and their mechanical influence.

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These figures would transform the manuscript from a data collection into a visually digestible analytical resource.

Declarations

Potential competing interests: No potential competing interests to declare.