

October 6, 2026

Dear Editor:

MS Editor-in-Chief:

Mechanical Sciences

We are very pleased to learn that this article has been accepted for publication in [Mechanical Sciences](#), titled “[Thermal stability of surface residual stresses in gear shaft subjected to ultrasonic impact treatment: A finite element simulation study](#)”(ms-2026-176; Previous Manuscript Numbers: [ms-2026-145](#) and [ms-2026-163](#)). The paper was coauthored by Xinbo Zhang, Zongrong Sun, and Xigui Wang.

Contribution of each individual co-author:

No conflict of interest exists in the submission of this manuscript, and manuscript is approved by all authors for publication. We would like to declare on behalf of our co-authors that the work described was original research that has not been published previously, and not under consideration for publication elsewhere, in whole or in part. All the authors listed have approved of the manuscript that is enclosed.

In this subject research, we present a review titled “[Thermal stability of surface residual stresses in gear shaft subjected to ultrasonic impact treatment: A finite element simulation study](#)”(ms-2026-176; Previous Manuscript Numbers: [ms-2026-145](#) and [ms-2026-163](#)). In this study, a 30CrMoA alloy steel drive shaft was investigated, and a combined finite element (FE) simulation and experimental approach was employed to systematically examine the effects of UIT on surface residual stress, microhardness, surface roughness, and microstructure, as well as the evolution of residual stress during thermal exposure at 65 °C. The results indicate that UIT introduced a residual compressive stress field extending to a depth of approximately 1.253 mm, with a surface stress of –320.98 MPa and a peak stress of approximately –723.74 MPa. The surface microhardness increased from 231 HV to 318 HV, accompanied by a hardened layer depth of approximately 1.14 mm, while the surface roughness Ra decreased from 0.8 µm to 0.18 µm. During thermal exposure at 65 °C, the surface residual compressive stress exhibited a relaxation behavior characterized by a rapid initial stage followed by a gradual stage with increasing holding time, stabilizing after 8 h with an overall relaxation rate of approximately 23.94%. Meanwhile, the surface hardness, hardened layer depth, and microstructure showed no significant changes, indicating that the work-hardening effect was well preserved. The FE simulation results agreed well with the experimental data, validating the reliability of the numerical model.

Our [main contribution to the field](#) is the systematic elucidation of the differentiated response between residual stress relaxation and work-hardening retention in ultrasonic impact-strengthened 30CrMoA gear shafts under in-service thermal conditions. By combining finite element simulation with experimental characterization, we demonstrate that although the surface residual compressive stress relaxes by approximately 23.94% after 8 h of thermal exposure at 65 °C, the work-hardening effect, reflected in surface microhardness, hardened

layer depth, and microstructure, remains essentially intact. This decoupling of stress relaxation from hardening stability provides, for the first time, a quantitative basis for predicting the long-term service reliability of UIT-treated transmission components operating at elevated temperatures.

The novelty and significance of this manuscript are as follows:

The work was studied mainly “[Thermal stability of surface residual stresses in gear shaft subjected to ultrasonic impact treatment: A finite element simulation study](#)”(ms-2026-176; Previous Manuscript Numbers: [ms-2026-145](#) and [ms-2026-163](#)). The work is studied mainly by integrating finite element simulation with systematic experimental characterization to investigate both the strengthening effects of ultrasonic impact treatment (UIT) on a 30CrMoA alloy steel drive shaft and, more importantly, the thermal stability of the strengthened layer under in-service temperature conditions. The key novel finding is the differentiated response between residual stress relaxation and work-hardening retention during thermal exposure at 65 °C: while the surface residual compressive stress relaxes by approximately 23.94% and stabilizes after 8 h, the microhardness, hardened layer depth, and microstructure show no significant degradation. This distinction has not been addressed in previous UIT studies, which have largely focused on room-temperature strengthening effects without considering in-service thermal stability. Furthermore, the experimentally validated finite element model established in this work enables quantitative prediction of residual stress evolution under thermal loading, thereby providing both mechanistic insight and a practical design tool for applying UIT to gear shafts and other transmission components operating at elevated temperatures.

Response to Reviewers' Comments:

Reviewer 1 (Report #1):

Q1. The description of equation 5 is not accurate. The authors need to find a continuum mechanics book or reference.

Sincerely respond to Q1 raised by Reviewer 1 (Report #1):

We sincerely thank the reviewer for this valuable comment. In response to this concern, we have revised the manuscript as follows:

When the Lagrange (Lagrangian) algorithm is employed for stress analysis, the coordinate system is attached to the analyzed object (i.e., the deformable body) and moves together with the material particles. The motion and deformation of the body are examined by tracking the positions of individual particles at successive instants. The equation of motion of a particle can be expressed as:

$$x_i = x_i(X_j, t), \quad i, j = 1, 2, 3 \quad (5)$$

where X_j denotes the material coordinates (i.e., the Lagrangian coordinates, taken as the coordinates of the particle in the initial configuration), t denotes the time of particle motion, and x_i denotes the spatial coordinates of the particle at time t . The initial condition $x_i(X_j, 0) = X_i$ is satisfied, meaning that the material coordinates coincide with the spatial coordinates at the initial instant.

Equation (5) describes the kinematic mapping of material points within the Lagrangian framework of continuum mechanics. In Section 3.2, we have revised the text accompanying Equation (5): the imprecise expression "moving particles" has been replaced with the standard continuum mechanics term "material points," and the description now explicitly distinguishes between the material coordinates X_j (reference configuration) and the spatial coordinates x_i (current, deformed configuration). In addition, as suggested by the reviewer, the classical textbook by Sedov (March 1966) has been cited in the text and added to the reference list.

Changes made in the manuscript: Section 3.2 (description of Eq. (5)) and the reference list.

Q2. For any screenshot from the software, please remove the background color.

Sincerely respond to Q2 raised by Reviewer 1 (Report #1):

We sincerely thank the reviewer for the valuable comments. In response to this concern, we have removed the background color of the software screenshots in the revised manuscript; this suggestion provides important guidance for our future research. The DEFORM simulation screenshot (Figure 2) originally contained a dark blue background, which has now been removed. We have also checked all other software-generated figures in the manuscript and eliminated any colored backgrounds from the screenshots.

Changes made in the manuscript: Figure 2 and the other software screenshots.

Q3. In Table 1, you need to write "Initial yield stress A (MPa)", etc. Please correct the rest.

Sincerely respond to Q3 raised by Reviewer 1 (Report #1):

We sincerely thank the reviewer for this careful observation. As suggested, we have revised Table 1 so that all parameters are presented in the standard format of "parameter name, symbol (unit)", e.g., "Initial yield stress A (MPa)", and the remaining entries have been checked and corrected accordingly.

We have conducted a thorough check of all mathematical expressions throughout the manuscript. All complete equations are now displayed on separate lines with sequential equation numbers, and no full equations remain embedded in the running text. Only individual symbols and simple variables are retained as inline math.

Changes made in the manuscript: a manuscript-wide check and reformatting of all mathematical expressions.

Q4. For any equations, it is not recommended to place them inside the main text. They should be treated as a single equation with an equation ID.

Sincerely respond to Q4 raised by Reviewer 1 (Report #1):

We sincerely thank the reviewer for the valuable comments. Following your suggestion, we have carefully reviewed the entire manuscript and standardized the formatting of all equations: those previously embedded within the text lines have been converted to display style, each set on a separate line and numbered sequentially. These revisions not only enhance the standardization and readability of the manuscript, but also serve as valuable guidance for our future submissions to your journal. We have revised the column headers of Table 1. The separator "/" between the parameter symbol and its unit has been replaced with parentheses, e.g., "Initial yield stress A (MPa)". All column headers in Table 1 now follow this unified format.

Changes made in the manuscript: Table 1.

Q5. For Figure 4, please make the font size of the description inside compatible with the main text. It can be larger, but it cannot be smaller. Improve the resolution, for example, in Figure 8. Please check and correct the rest.

Sincerely respond to Q5 raised by Reviewer 1 (Report #1):

We sincerely thank the reviewer for the valuable comments. In response to this concern, we have carefully examined and revised all figures throughout the revised manuscript: the font size of the text within the figures has been uniformly adjusted to be no smaller than that of the main text, and the resolution of the figures has been improved accordingly. These revisions apply to Figs. 3, 4, and 8, among others.

(1) For Figure 4: We have adjusted the font size of the in-figure text so that it matches the main text and is no smaller than the main text size. (2) Regarding image resolution: Figure 8 has been re-exported from the original Origin project at a resolution of 300 dpi. We have also systematically checked all figures throughout the manuscript, and all low-resolution figures have been replaced with high-resolution versions.

Changes made in the manuscript: Figure 4 (font size); Figure 8 and all other figures (resolution improvement).

Thank you and best regards.

Sincerely,

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