

KIStE

AI-based damage analysis of technical elastomers

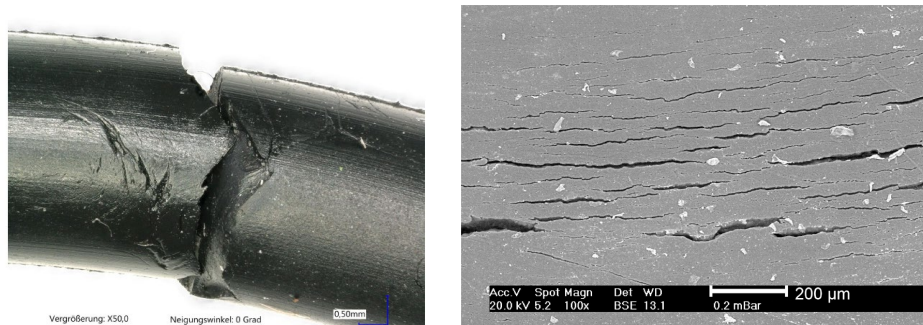


Figure: Damaged O-ring and example of fatigue cracks; REM image (Source: VDI 3822).

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Fast and Easy Identification of Elastomer Damage

Due to the wide variety of damage patterns in elastomer components, tracing back to the root cause of the damage is not always straightforward. In the internal Fraunhofer project »AI-Based Damage Analysis of Technical Elastomers – KISTE« possibilities were explored for objectively assessing damage cases using artificial intelligence. The developed process, demonstrated with simple components, can be transferred to customer-specific applications.

Objectivity and Efficiency

Elastomers are used in high-tech products that ensure functionality and safety in a wide range of applications. They are used, among other things, as seals, flexible connecting elements, vibration dampers, transport profiles, or insulators, and are usually subject to high demands. Mechanical and thermal stresses as well as various media influences can cause complex damage, resulting in economic losses and potential hazards for users. Damage to components can be analyzed using VDI 3822. However, experience and expertise as well as similar damage patterns with different causes of damage lead to a subjective assessment of damage in this process. In the KISTE project, this time-consuming and cost-intensive process was automated and objectified, and the necessary framework conditions (e.g., input parameters, training database, extrapolation potential, etc.) for practical implementation were explored.

Automated detection of specific causes of damage

The first step in objectively evaluating the causes of damage to elastomers focused on image-based data analysis. For a selection of defined types of damage, damage images were generated, the causes of damage, the severity of damage, and the respective evaluation criteria were grouped into classes, and specific training data sets were created. Since there are typically not enough damaged parts available to train an AI model, various data augmentation methods such as geometric transformations, color changes, etc. were investigated and applied in terms of their effectiveness. In the second step, the process chain was expanded from an image-based classification model to a multi-stage, multimodal classification model. To this end, easily determinable material parameters were added to increase the accuracy of damage determination and make the classification process more robust overall. Current research focuses on the transferability of the process chain to damage cases outside the training data set and on the integration of explainable artificial intelligence.

Industrial applications

The scientific research conducted as part of the KISTE project focused on methodological approaches to ML-based damage analysis. The findings are now to be transferred to industrial practice and applied to other elastomer components. To this end, we are looking for industrial companies that would like to use innovative AI solutions for their maintenance, quality, and analysis processes and are interested in actively collaborating on the further development and implementation of the methodology. Take advantage of this opportunity to work with us to unlock the potential of AI for your business.