

Cracking the code of CV joint failures

How advanced SEM technology ensures automotive safety and reliability

The problem

Constant-velocity (CV) joints are the unsung heroes of automotive power transmission systems. They seamlessly transfer power through variable angles at a constant rotational speed from the differential to the wheel hub, driving the vehicle forward. However, these joints operate under significant torsional stress and are prone to failure, especially under repetitive conditions.

When a CV joint fails, it can lead to catastrophic consequences. Understanding the root cause of such failures is crucial to detecting and preventing malfunctions early. The process of metal failure analysis typically includes:

- Macro fracture analysis
- Microstructure analysis
- Chemical composition analysis
- Microhardness analysis

Scanning electron microscopy (SEM) is particularly vital in microstructure analysis. SEM images help identify the type of material fracture and assist in analyzing the possible causes of fracture or crack initiation.

The impact

Metal failures occur regularly, especially in moving automotive parts. Failure analysis is essential to controlling the quality of parts and ensuring overall vehicle safety. Without timely and accurate failure analysis, the risk of recurring failures and potential safety hazards increases significantly.

The challenge

In this case, a CV joint fracture occurred during the assembly process. Most metal failure samples are large, requiring a large sample holder for the SEM that makes it possible to study the complete material on both elemental and on compositional levels.

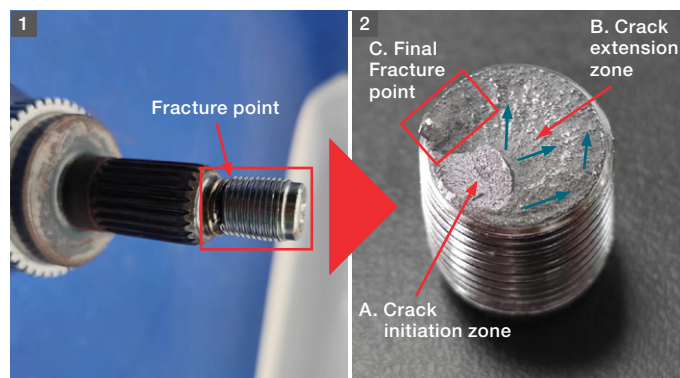


Figure 1. Outer joint of constant-velocity joint. Figure 2. Macrostructure of fracture.

The solution

Enter the Thermo Scientific™ Phenom™ XL Desktop SEM, which can accommodate individual samples as large as 10 cm by 10 cm or up to 36 half-inch samples. It requires minimal user training, and it delivers results within minutes. This powerful tool was used to analyze the CV joint fracture. The integrated Thermo Scientific™ Nav-Cam™ Sample Navigation Camera helped the operator quickly locate the desired position of the sample and link it to the macro analysis result.

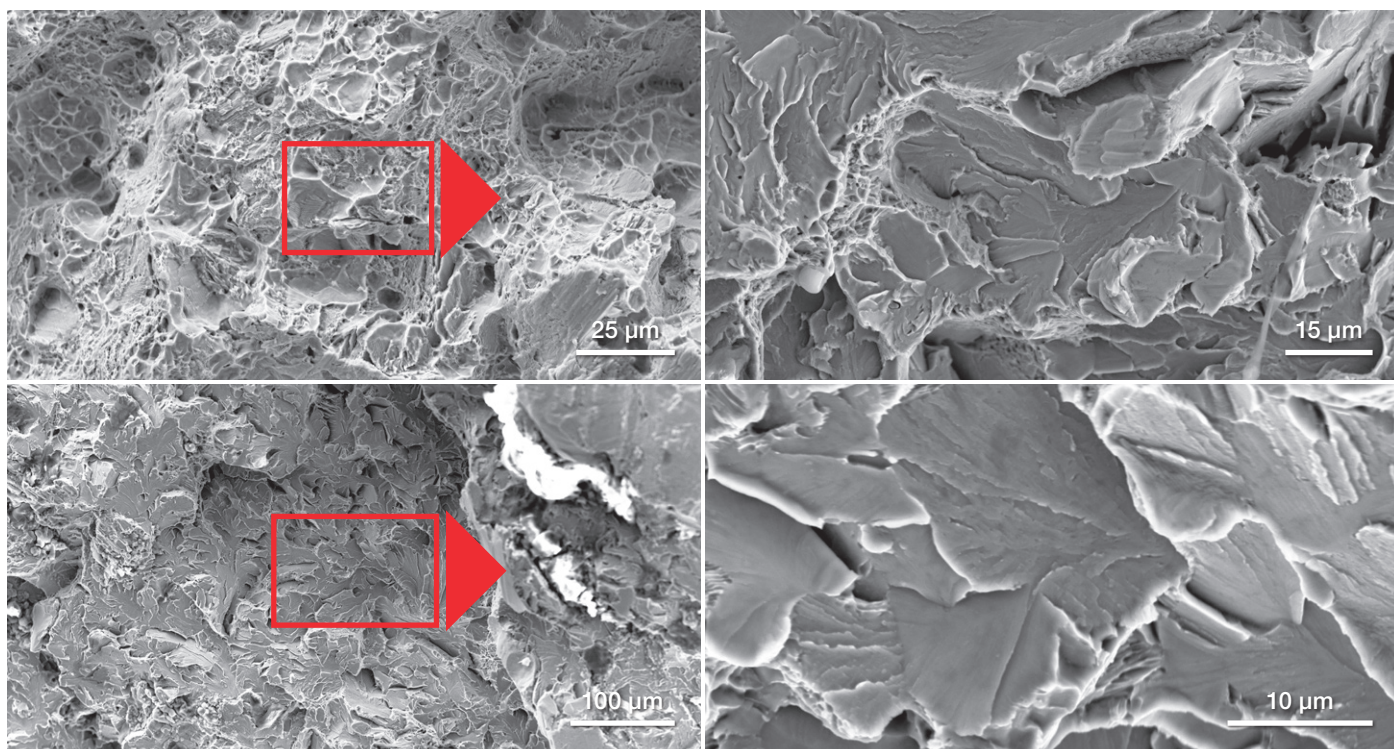


Fig 3 Quasi-cleavage fracture zone.

The results

The secondary electron images in Figure 3 show a so-called quasi-cleavage fracture zone in area A, where minute areas of plastic deformation are visible. River-line patterns are characteristic features of granular (cleavage) fracture, and the connected plateaus show the direction of the crack propagation.

A crack that propagates from inside out of the metal part, like in this case, is likely to be caused by an internal material defect, like a dislocation plane. Analyzing the sample over all the different production steps makes it possible to map the individual steps to their impact on material integrity.

SEM plays an essential role in metal fracture analysis. The Phenom XL Desktop SEM's large sample holder, ease of use, and fast imaging make failure fracture analysis more efficient. This case study demonstrates the importance of timely and accurate failure analysis in ensuring the safety and reliability of automotive components. By cracking the code of CV joint failures, we can drive forward with confidence, knowing that our vehicles are built on a foundation of quality and safety.

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