

## **METALLURGICAL ANALYSIS IN THE OUTER TUBE FAULT AREA**

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### **ABSTRACT**

In the automotive manufacturing industry, product failures are still found. In this study, one of the automotive components, namely the outer tube of the motorcycle front fork, was cracked. The outer tube is part of the shock absorber component which is also connected to the motorcycle steering system. Failure analysis aims to obtain some data or facts that can indicate the root cause of the failure or failure. Sample preparation which includes the process of selecting the cut area, cleaning and cutting for the fractography process. As for metallography, sample preparation is continued with the process of mounting, sanding, polishing and etching. Fractographic test showed that the fracture occurred in a brittle fracture mode, with no traces of plastic deformation. The morphology of the fracture surface also shows the presence of gas trapped in large quantities. In the metallographic test, the overall microstructure shows an eutectic phase with a uniform dendrite structure pattern, this indicates that metal solidification occurs quite quickly and can cause a lot of gas to be trapped in the metal characterized by the presence of multiple porosities. This can provide an indication of the relationship between the microstructure and the fracture surface morphology. Cracking and brittle fracture can be caused by the stress that occurs in the metal that exceeds the yield and plastic limits due to the large pressure of gas trapped in the metal.

Keywords: front fork; failure analysis; motorcycle; tube outer

### **INTRODUCTION**

Efforts to improve quality and efficiency are always carried out by the company in various fields, both in terms of technology, material selection and competitive design. On the production or manufacturing process side, total production capacity will increase if the number of failed or defective products can be minimized. Related to this, the company always makes efforts to improve through the field of research and development, even in certain cases, the company conducts research collaborations with other parties who are considered to have a reputation.

In its development so far in the automotive manufacturing industry there are still cases of product failure or defective products, this is of course inseparable from a cause that is in the history of the product manufacturing process. In this study, one of the automotive components, namely the outer tube of the motorcycle front fork, was cracked. The outer tube is part of the shock absorber component which is also connected to the motorcycle's steering system, so it can be said that this component is very vital for the overall motorcycle system from the aspect of safety, stability dynamics and comfort.

### **METHOD**

Failure analysis aims to obtain some data or facts that can indicate the root cause of the failure or failure. Sample preparation which includes the process of selecting the cut area, cleaning and cutting for the fractography process. As for metallography, sample preparation is continued with the process of mounting, sanding, polishing and etching. Based on the test results data, further study or analysis is carried out to obtain factual evidence that can be used as the basis for drawing up conclusions.

## RESULT AND DISCUSSIONS

The research sample is a tube outer which is a component part of a motorcycle front fork. This outer tube component is cracked and broken before being used. A photo of this tube outer fracture can be seen on figure 1 below.



Figure 1. Crack on Tube Outer

The following shows the results of the fractography test using macro photos. Based on the morphology of the fracture surface that looks like lumps (concave-bulges) in figure 2a and 2b, where there are no visible traces of plastic deformation which are generally like grooves (beachmarks).



Figure 2a. Concave-Bulges Morphology on Fracture Surface (mag. 6x)

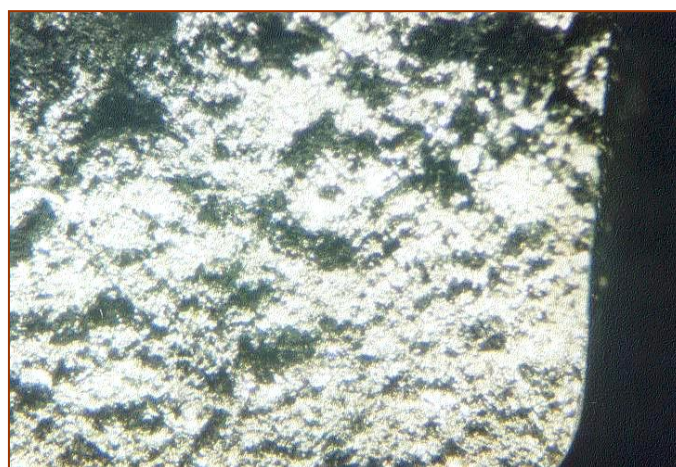


Figure 2b. Brittle Fracture Surface (mag. 6x)

The metallographic test results can be seen in the image below with several different magnifications to be able to observe more clearly the existing microstructure. The eutectic phase appears with a dendrite structure and quite a lot of porosity and is quite large in size (figure 3a, 3b dan 3c).

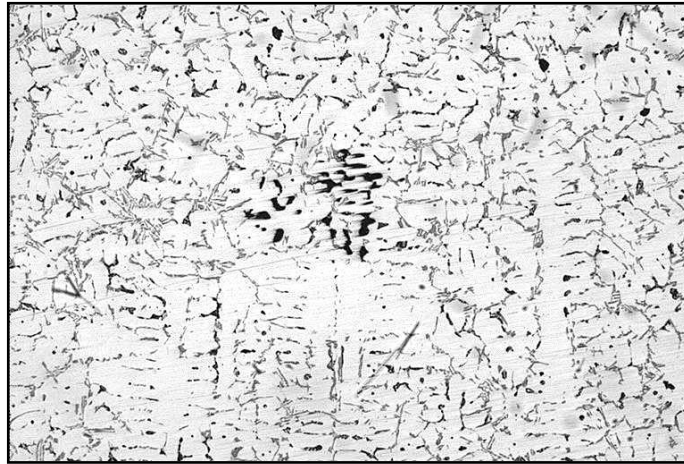


Figure 3a. Outer Tube Microstructure (visible dendrite structure and porosity between the aluminum matrix, mag. 140x)

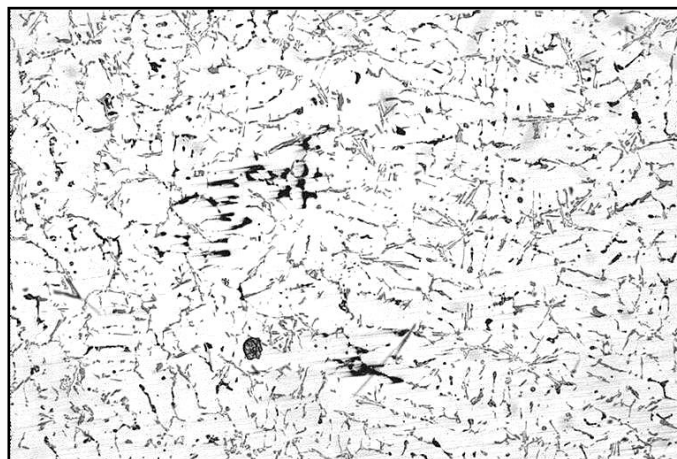


Figure 3b. Outer Tube Microstructure (visible dendrite structure and porosity between the aluminum matrix, mag. 140x)



Figure 3c. Outer Tube Microstructure (visible eutectic phase and porosity between the aluminum matrix, mag. 550x)

Based on the morphology of the fracture surface from the results of the fractography test, information can be obtained where the fracture occurs in a brittle fracture mode. This was also reinforced by the fact that there were no traces of plastic deformation found on the fracture surface. Observations on the morphology (protrusions-dents) that appear characteristically indicate that there is a lot of gas trapped in the metal before fracture occurs. A collection of gases trapped in large quantities will certainly put a lot of pressure on the metal which starts when the metal freezes. The existence of many shafts in the microstructure of a metal component will reduce the micro-sectional area and contribute to a significant increase in stress when the metal component is subjected to normal loads. This condition will be coupled with the great pressure from the gas collection contained in the metal.

The results of the metallographic test are the data needed to strengthen the results of the fractographic test in more detail. Various facts on the observation of the fracture morphology will be consistent with the evidence shown on the microstructure. The overall microstructural conditions show a eutectic phase with a uniform dendrite structure pattern. This provides information on the entire freezing process experienced by the metal. Metal freezes quite quickly, this can be the cause of trapping a lot of gas in the metal. Besides that, from the microstructure, it can be seen that there are many porosities with quite large sizes. This can provide an indication of the relationship between the microstructural conditions and the fracture surface morphology of the component.

## **CONCLUSIONS**

Based on the research that has been done, the tube outer component experiences cracking and brittle fracture due to the stress that occurs in the metal that exceeds the yield and plastic limits due to the large pressure of gas trapped in the metal.

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