# Effect of contamination on the mechanical properties of aluminum-silicone adhesive joints

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## Introduction

When contamination is present at the surface of adhesive joints with metallic substrates, it can either **remain at the adhesive/substrate interface** (Figure 1), resulting in a physical separation between them, or be **absorbed by the adhesive**, changing its properties, particularly at the interphase (Figure 2).

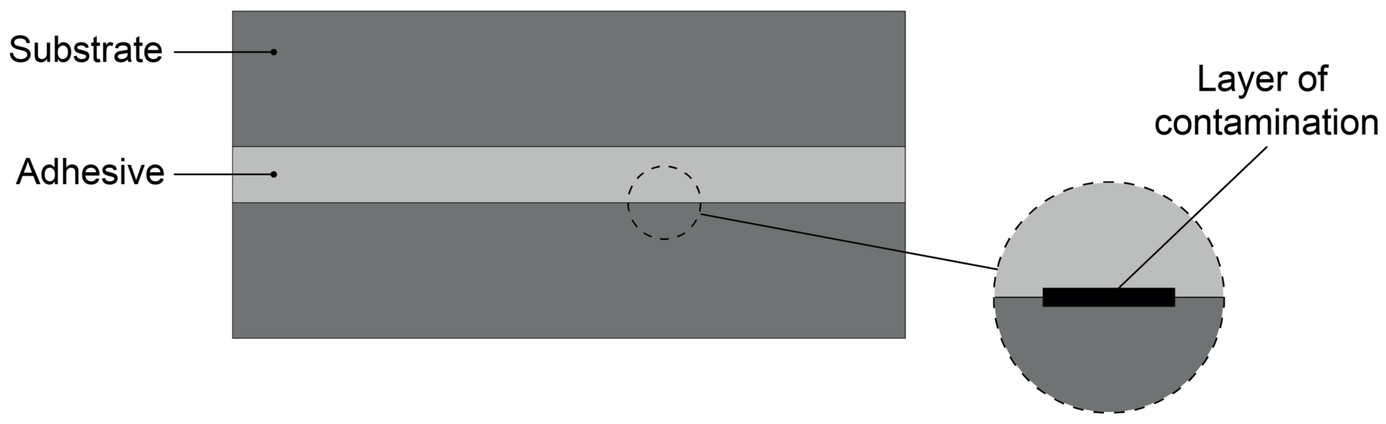


**Figure 1 –** Contamination and the adhesive/substrate interface.


**Figure 2 –** Contamination absorbed by the adhesive at the interphase.

The contaminant considered in this work is a **surfactant** used to clean oil off aluminium, after the manufacturing of the component.

## Experimental details

The strength properties of the contaminated joints with **aluminum substrates** and a **silicone adhesive** were analyzed using single lap joints (**SLJ**) and the fracture processes using double cantilever beams (**DCB**).

The substrates were treated with sandpaper and anodized. Afterwards, a **water/surfactant mixture** (with a concentration of 10 g/L) is applied to the substrate, with the contamination levels being established by the **number of sprays deposited**. It is also ensured that **only surfactant is at the substrate prior to bonding** (Figure 3).

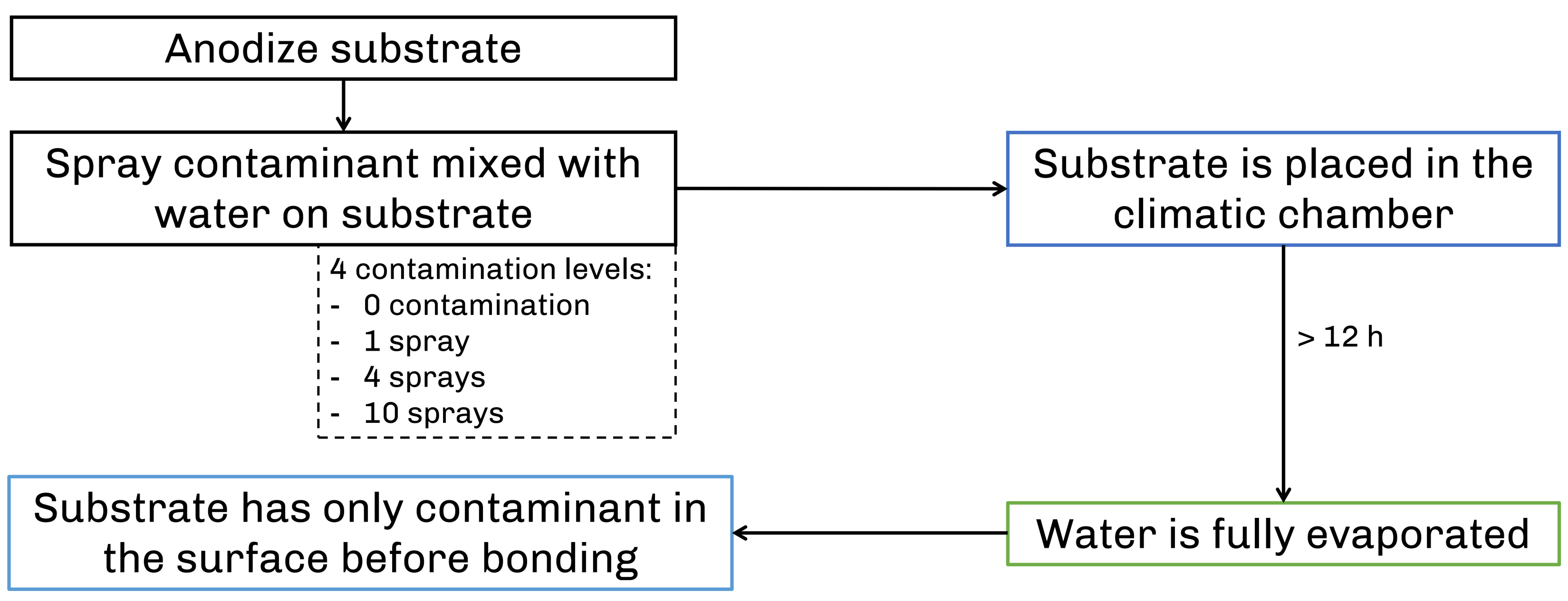


**Figure 3 –** Substrate treatment procedure prior to bonding.

## References


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## Experimental results

### 1. Double cantilever beam (DCB)

Representative **load-displacement curves** obtained from DCB tests for each contamination level are presented in Figure 4.

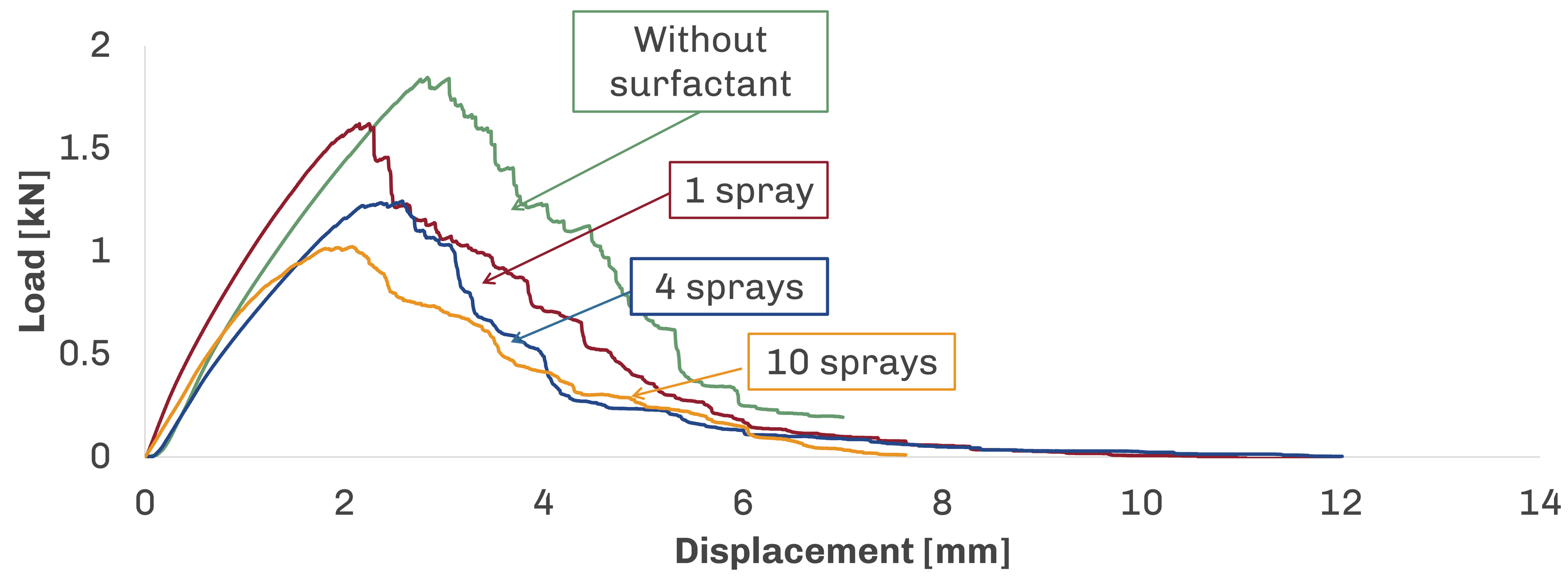


**Figure 4 –** Representative load-displacement curves for DCB tests for each contamination level

### 2. Single lap joints (SLJ)

Representative **load-displacement curves** obtained from SLJ tests for each contamination level are presented in Figure 5.

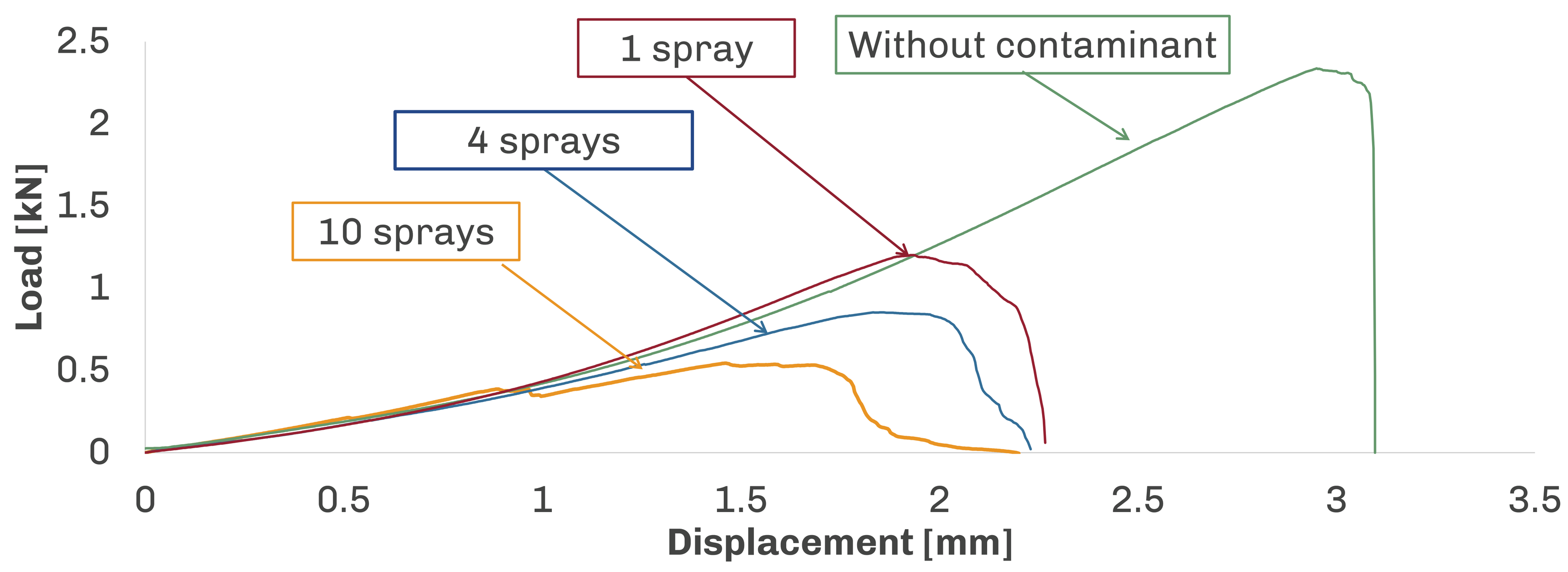


**Figure 5 –** Representative load-displacement curves for SLJ tests for each contamination level

### 3. Failure surfaces

The typical **failure surfaces** obtained for each contamination level for DCB and SLJ are shown in Figure 6.

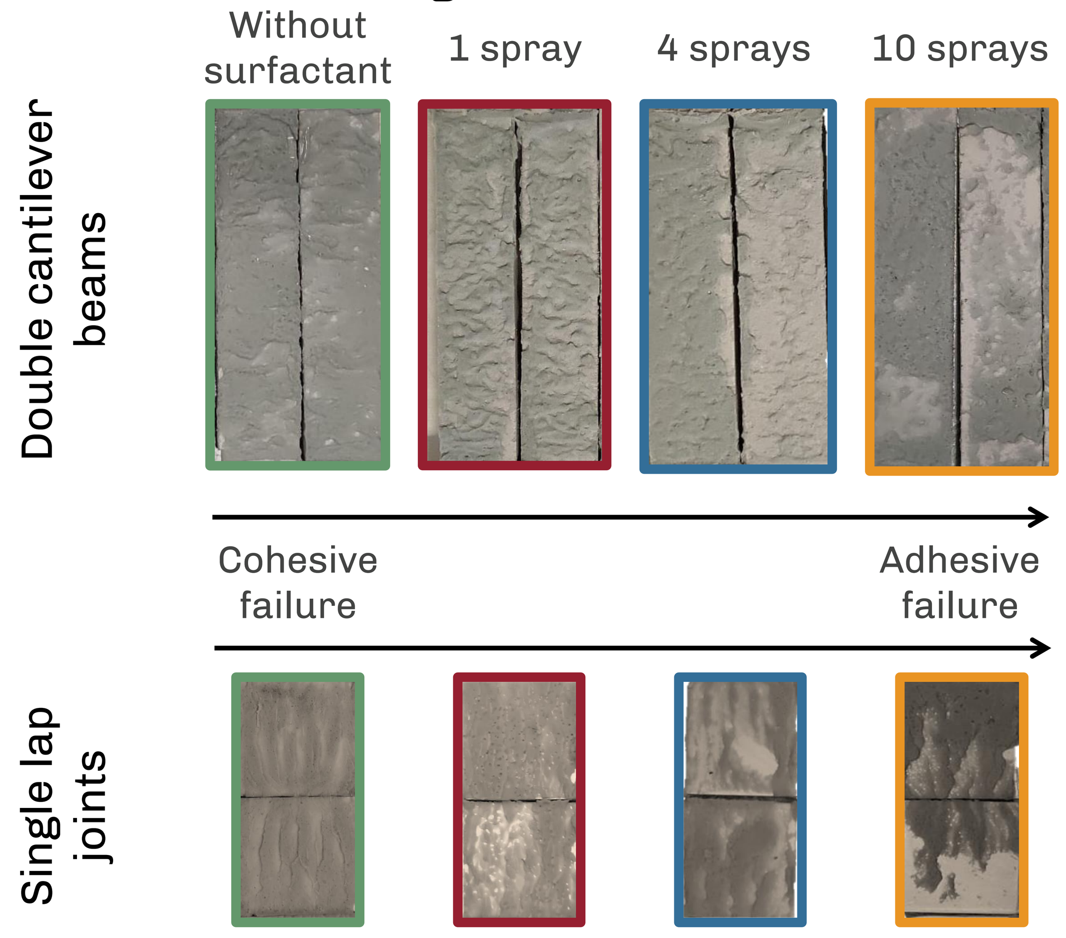


**Figure 6 –** Fracture surfaces for each contaminant level tested, for SLJ and DCB.

## Conclusions

As the contamination at the surface of the substrate increases, the **failure is progressively interfacial** and the **failure load decreases**. Without contaminant both the DCB and SLJ exhibit cohesive failure, for 1 and 4 sprays of contamination, the **failure path moves closer to the substrate**, as the adhesive near the interface **absorbs contaminant** and weakens its mechanical properties, Figure 7a. As the contamination content increases, the adhesive becomes unable to absorb all the contaminant, leading to **interfacial failure**, Figure 7b.

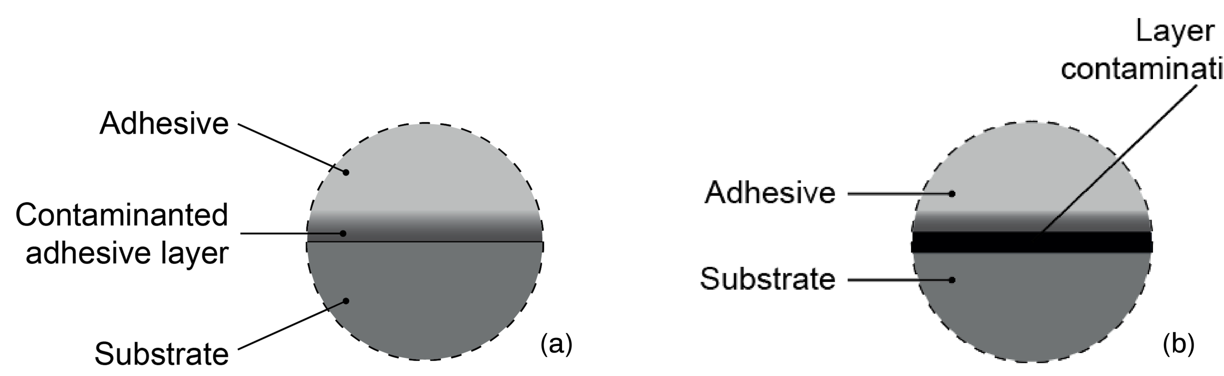


**Figure 7 –** Contamination scenarios found for 1 and 4 sprays (a) and for 10 sprays (b).

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