Surfactant contamination on the surface of aluminum substrates and its effect on the adhesive and adhesive joint

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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 1a), resulting in a physical separation between them, or be **absorbed by the adhesive**, changing its properties, particularly at the interphase (Figure 1b).

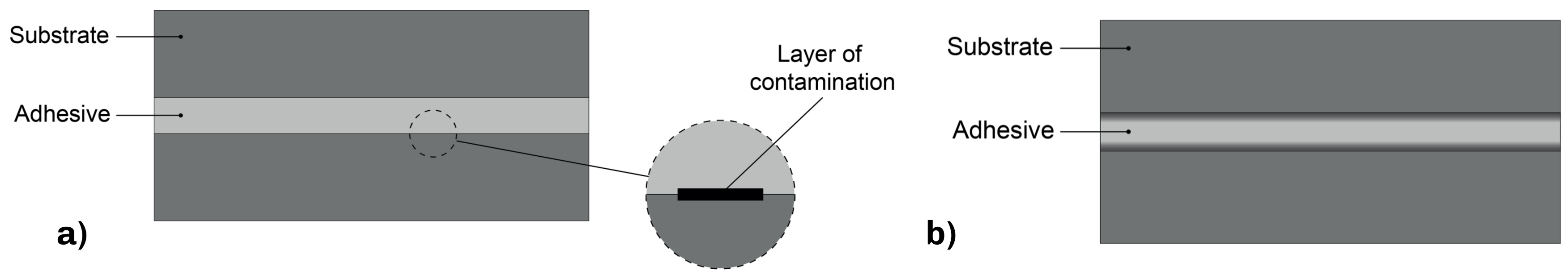

Figure 1 – Contamination and the adhesive/substrate interface a) and contamination absorbed by the adhesive at the interphase b).

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

Experimental details

The failure load of 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 2).

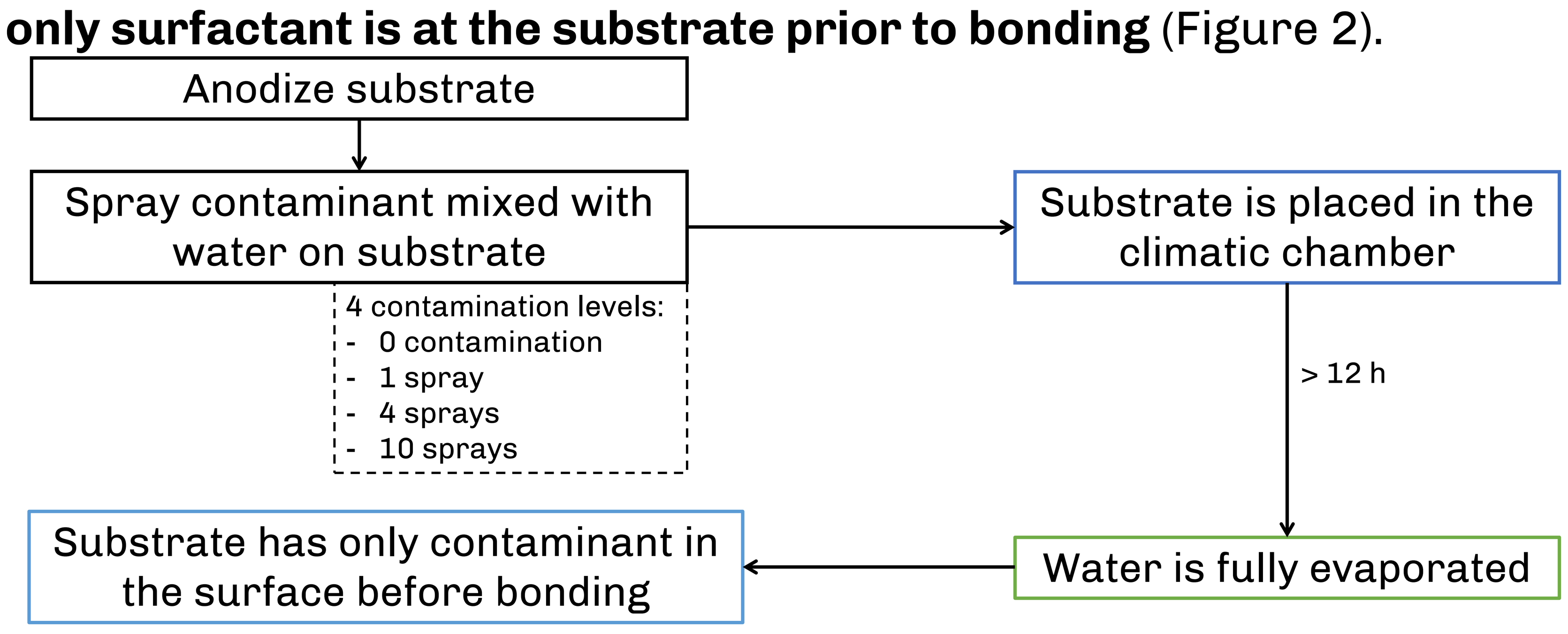

Figure 2 – Substrate treatment procedure prior to bonding.

Bulk tensile tests, SEM and FTIR analysis were performed using **silicone adhesive** with **2%, 5% and 10% of surfactant** mixed into the material prior to curing.

Experimental results

1. Double cantilever beam (DCB)

Representative **load-displacement curves** obtained from DCB tests for each contamination level are presented in Figure 3.

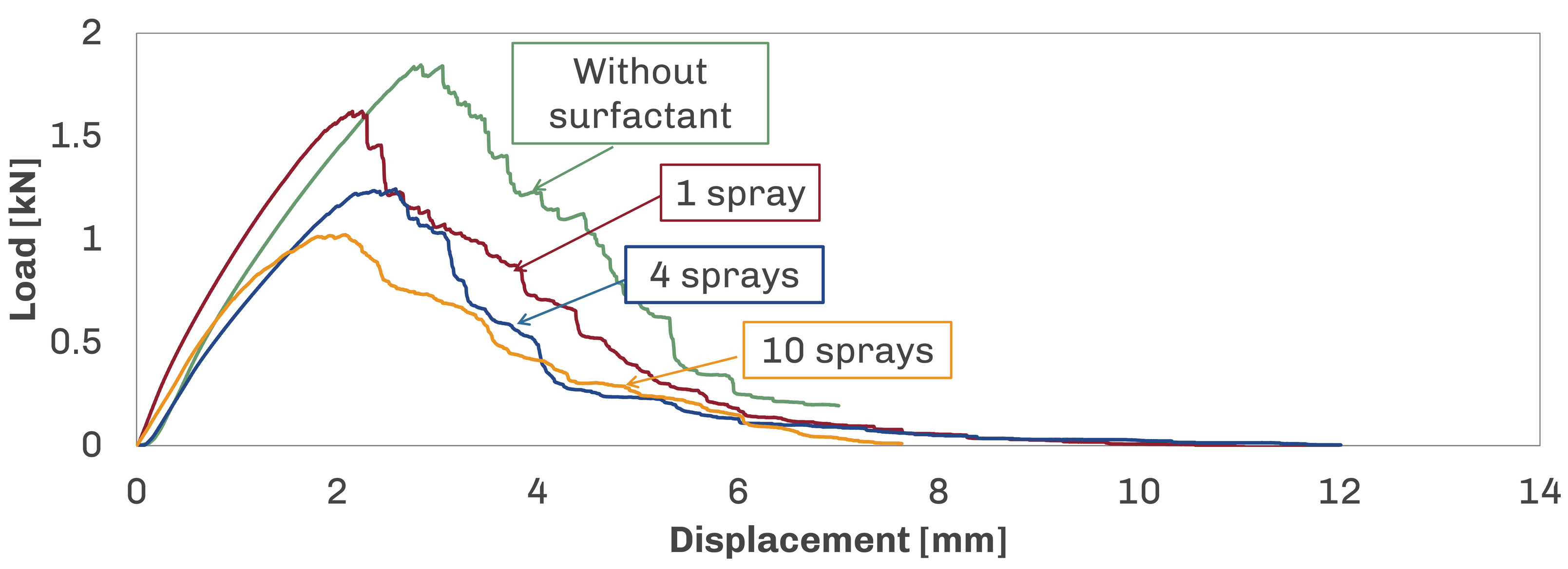

Figure 3 – Representative load-displacement curves for DCB tests for each contamination level

2. Single lap joints (SLJ)

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

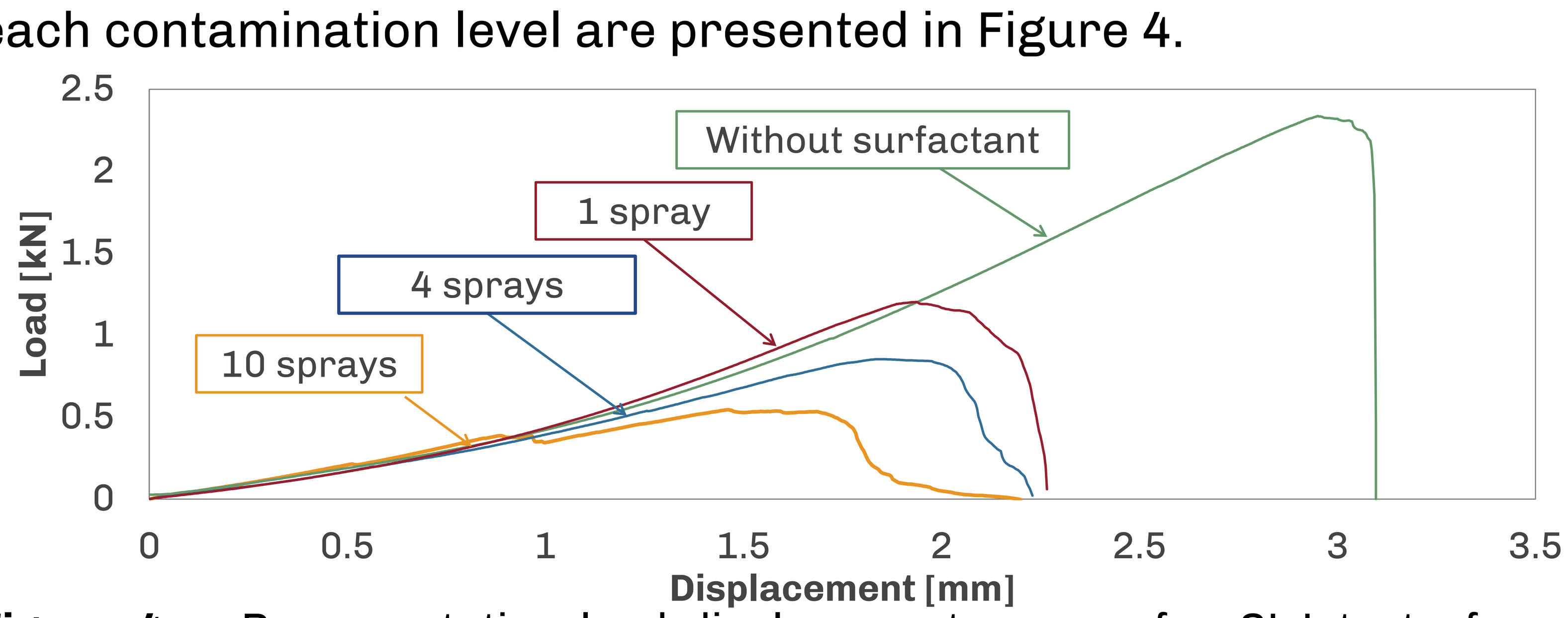

Figure 4 – Representative load-displacement curves for SLJ tests for each contamination level

3. Failure surfaces

The typical **failure surfaces** obtained for each contamination level for DCB and SLJ are shown in Figure 5.

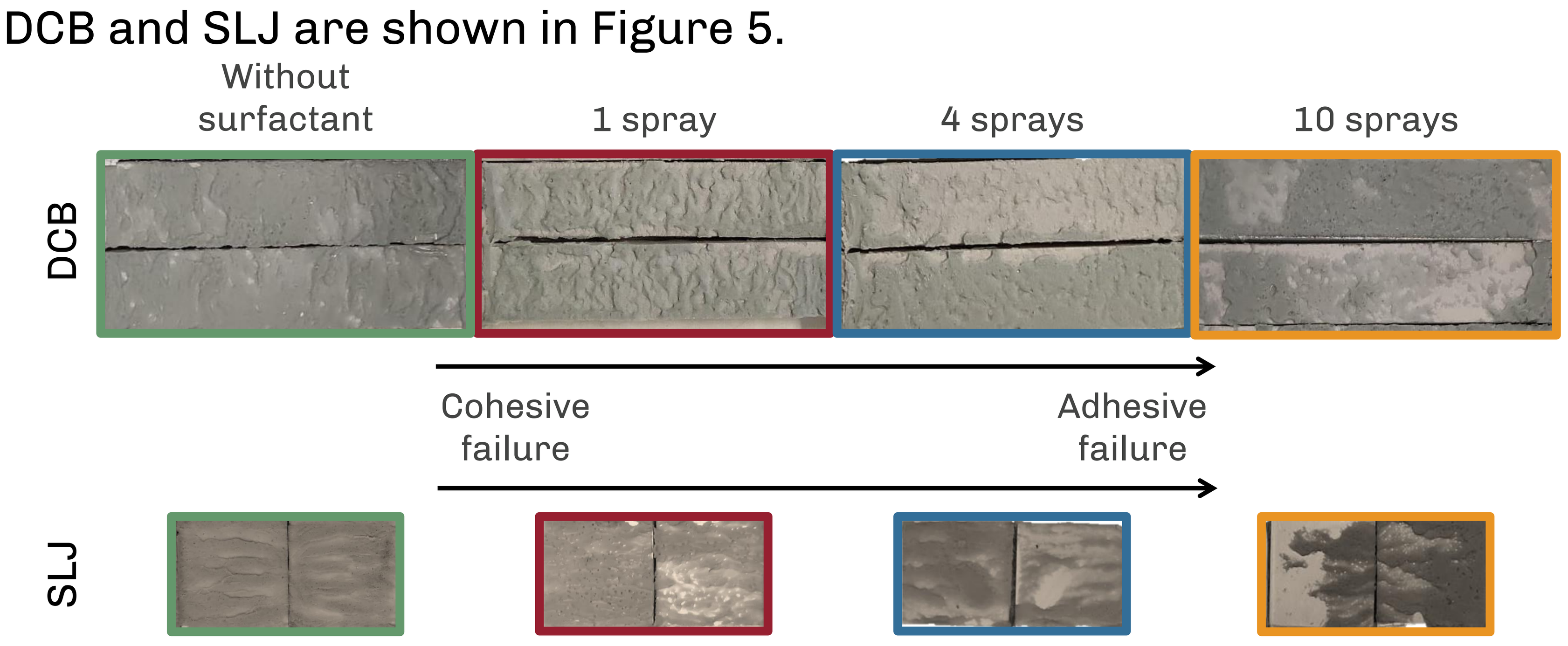

Figure 5 – Fracture surfaces for each contaminant level tested, for SLJ and DCB.

4. Analysis of the bulk adhesive

The results for the **SEM** analysis of the fracture surface of bulk specimens as well as the **FTIR** analysis and **bulk tensile tests** conducted are presented in Figure 6.

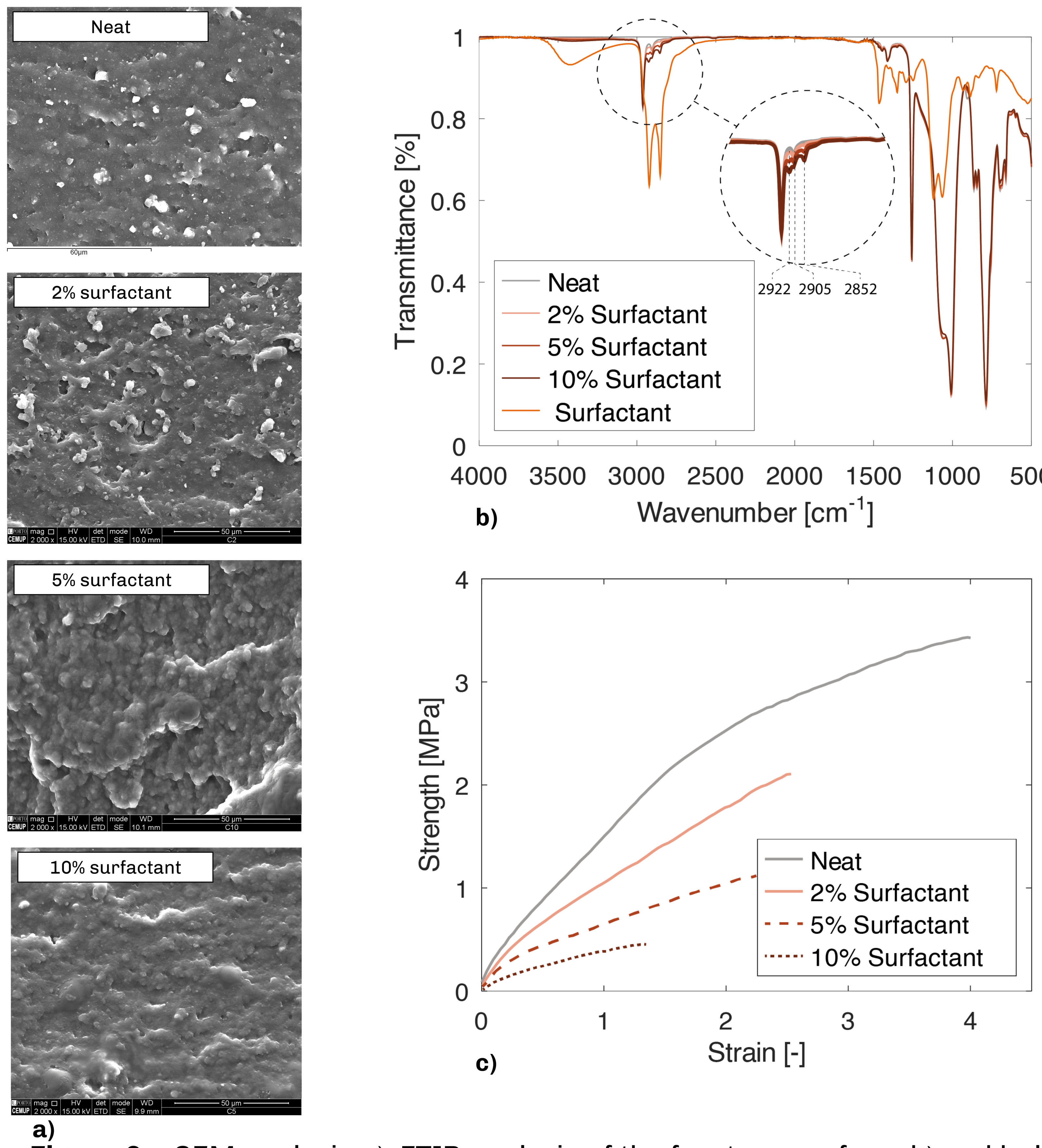

Figure 6 – SEM analysis a), FTIR analysis of the fracture surface b) and bulk tensile test results c).

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 1b. As the contamination content increases, the adhesive becomes unable to absorb all the contaminant, leading to **interfacial failure**, Figure 1a.

References

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