



**Thesis project:**

Mucosal rheology in the airways  
of patients with severe lung disease

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**RHEOLOGICAL ANALYSIS RESULTS OF NASAL ASTHMATIC MUCUS:**

This annex, introduced in Chapter n.3 of the thesis, shows the analyses results carried out on nasal mucosa samples from subjects suffering from asthma. These samples has been provided by the C2VN laboratory of the University of Aix-Marseille.

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## **SCREENING OF ANALYSES**

The SAOS and CSS analyses of the 32 nasal mucosa samples carried out during the thesis period at the M2P2 laboratory are shown in the following graphs (figures 1 and 2). The tests on the samples were conducted with the same specifications as those used for cellular mucosa (see chapter n.2 of the thesis). The analysis of the data obtained from the tests (in particular CSS) was also carried out using the same steps and programmes set out in chapter 2 of the thesis.

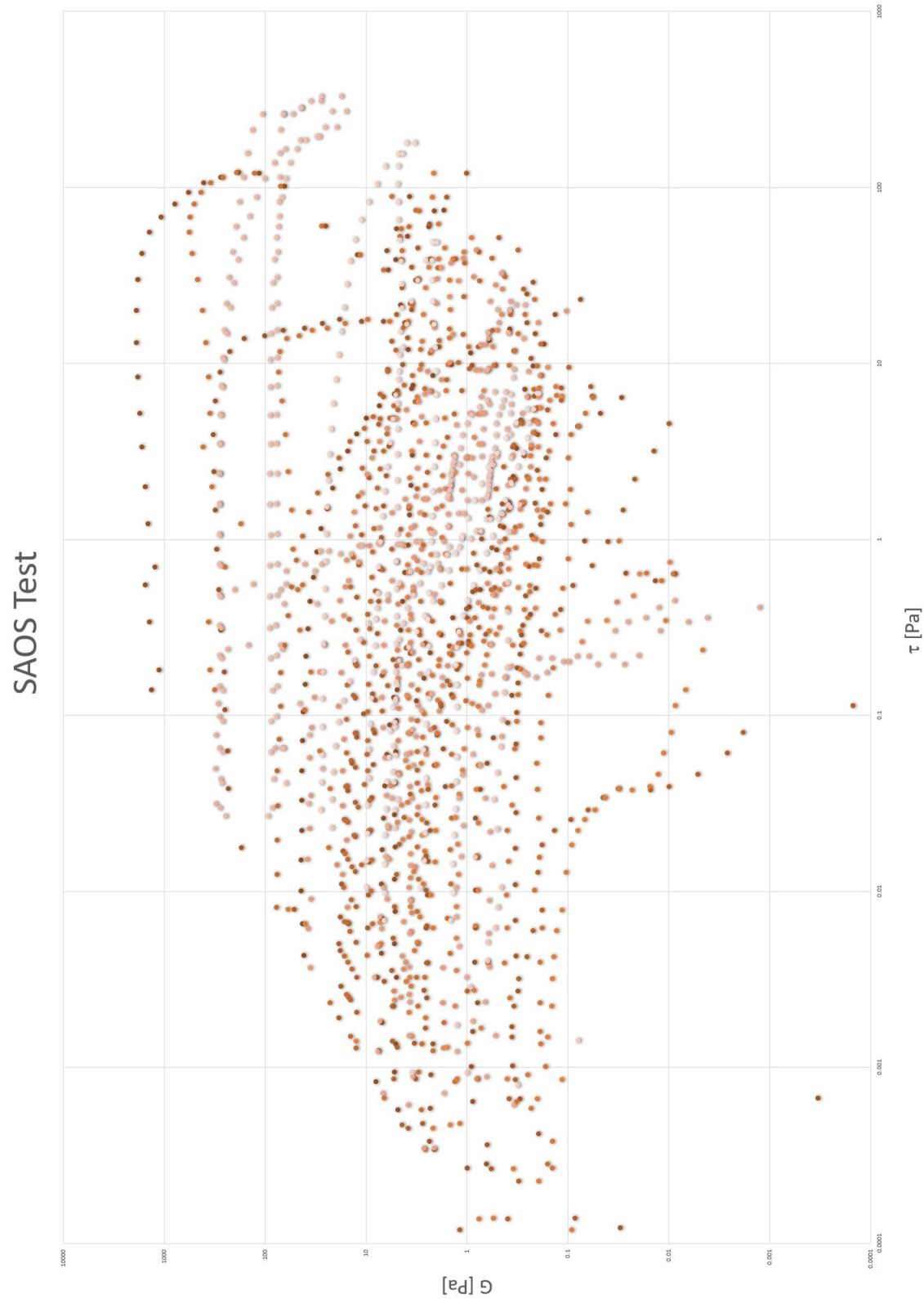


Figure 1 SAOS results by the nasal asthmatic mucus analysis

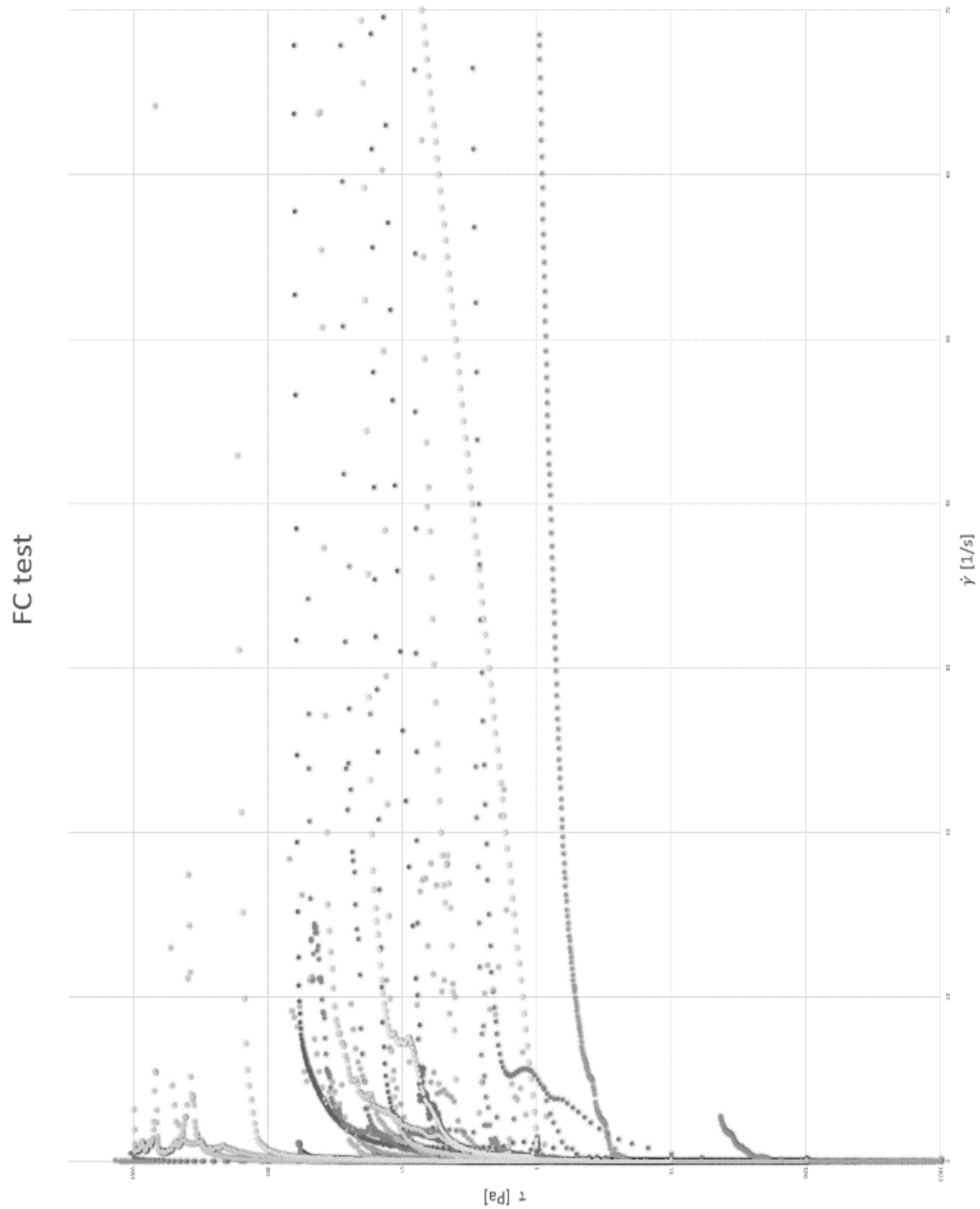


Figure 2 results by the nasal asthmatic mucus analysis

## NASAL AND CELLULAR MUCUS RHEOLOGICAL DIFFERENCES

The nasal mucosa differs from the pulmonary mucosa not only in the type and concentration of mucins, but also in its pH and hydration (102- 103). In addition, the nasal mucosa is much more susceptible to external contamination, as it is subjected to a lower filtration content of exogenous substances. These factors undoubtedly influence the variance of the experimental data. It is therefore not surprising to observe an  $\overline{CV}$  (calculated as reported in Chapter 2) of 187%, with variations in the parameters studied of up to three orders of magnitude. This phenomenon occurs mainly for the elasticity of the mucus  $G'$ ,  $\tau_0$  and  $k$ . It is additionally observed that the average values recorded for the parameters of bronchial asthmatic mucosa (presented in Chapter 2 and reported as red dots in the figure 3) are within the range of asthmatic nasal mucosa (white dots of the figure 3). However, they seem to be higher respect to the average of the asthmatic one. It does not occur for the viscoelastic and shear thinning parameters ( $n$  and  $\tan \delta$ ), that seems not to vary between nasal and bronchial mucus.

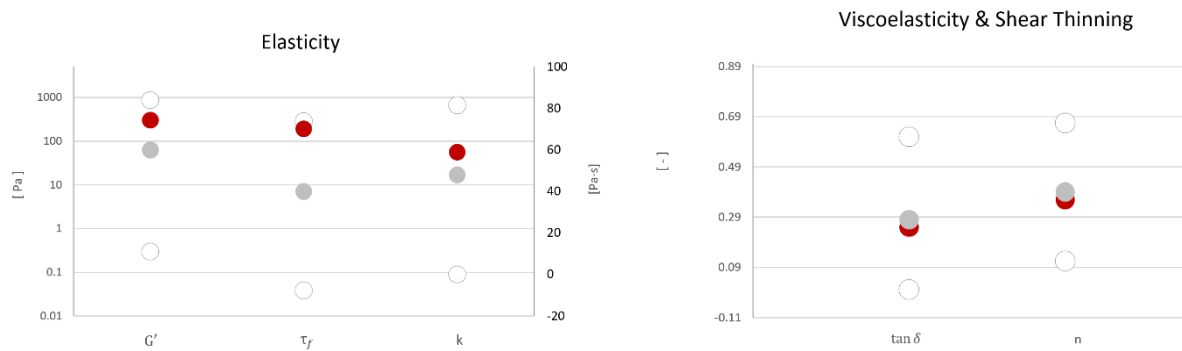


Figure 3 Elastic, viscoelastic and shear thinning variables of asthmatic nasal (white and red dots) and bronchial (grey dots) mucus.

Unlike the cellular mucosa, a storage time of the sample between the sampling and the measurement is known. This allows us to verify how the ageing phenomenon degrades the elasticity of the mucosa, even when it is stored in a sterile and thermally controlled (approx. 4°C) environment. In figure 4, we have compared the rheological parameters obtained for nasal asthmatic mucus samples stored during 1-2 days (white bars) or for 3-31 days (grey bars). The aging phenomenon induces to an increase of the viscoelasticity while it seems to have no particular effect on the shear thinning properties of nasal mucus.

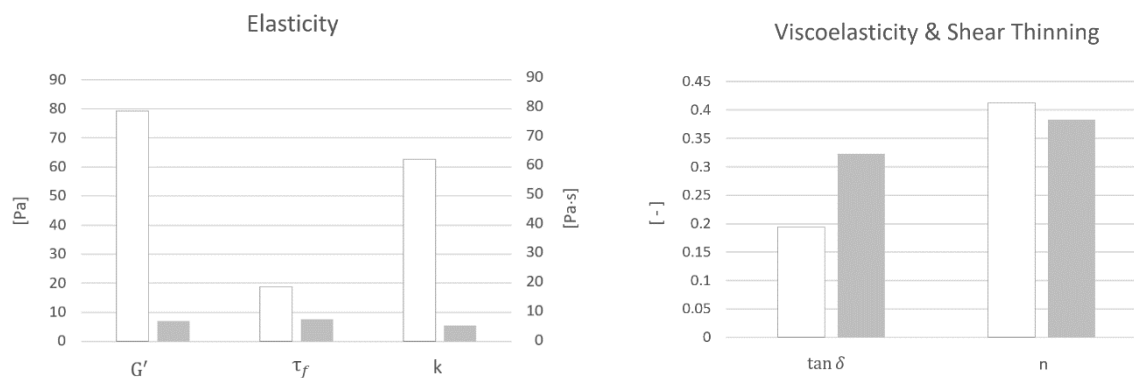


Figure 4 Elastic, viscoelastic and shear thinning variables of asthmatic nasal mucus stored for 1-2 (white bars) or 3-31 (grey bars) days.

## FURTHER CONSIDERATIONS AND FUTURE PROSPECTS

The project developed by the two laboratories M2P2 and C2VN also aims to obtain a complete picture of the mucosa examined. Future research will therefore aim to correlate chemical, rheological and contextual characteristics, assessing how each evidence in a patient's medical record may influence the structure and behaviour of his or her mucosa. For this reason, each patient's asthmatic mucosa data is accompanied by additional information such as age, the therapies he or she is undergoing, gender, if he or she is a smoker or not etc.

The characterisation process is still in its early stages and the data in our possession do not yet allow us to provide more precise evidence. Despite from that, has been registered an increase in elasticity and viscoelastic decreasing the shear thinning in older subjects (between 53 and 74 years) compared to younger ones (between 28 and 36 years) (figure number 5). In any case, as mentioned, the nasal mucosa does not appear to be the focus of this thesis and therefore a more accurate analysis will be postponed to later studies.

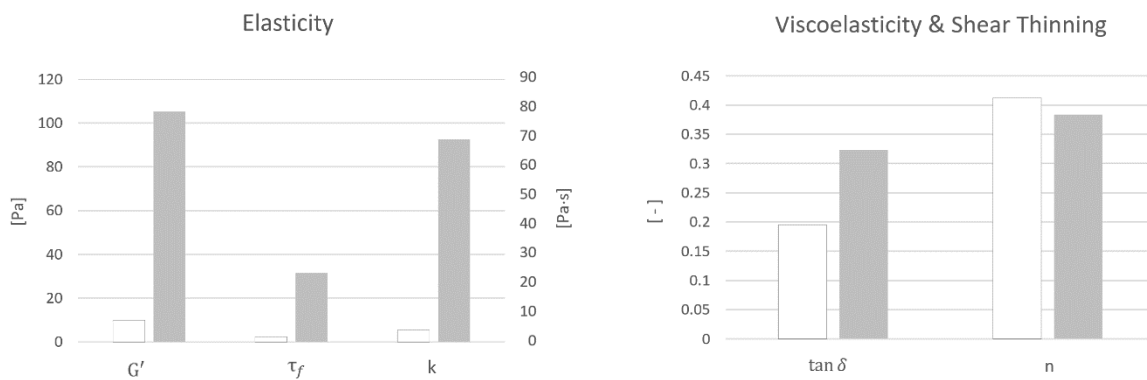


Figure 5 Elastic , viscoelastic and shear thinning variables of asthmatic nasal mucus of young (white bars) and old (grey bars) days.