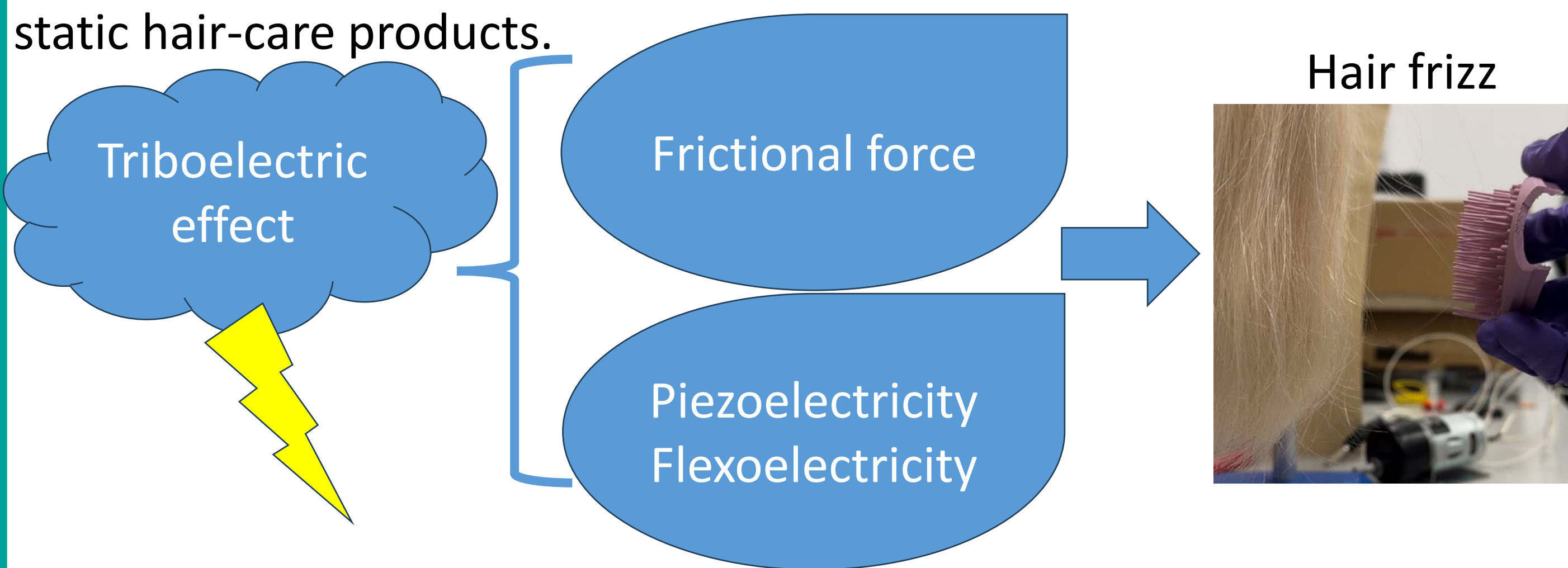


## Project Background

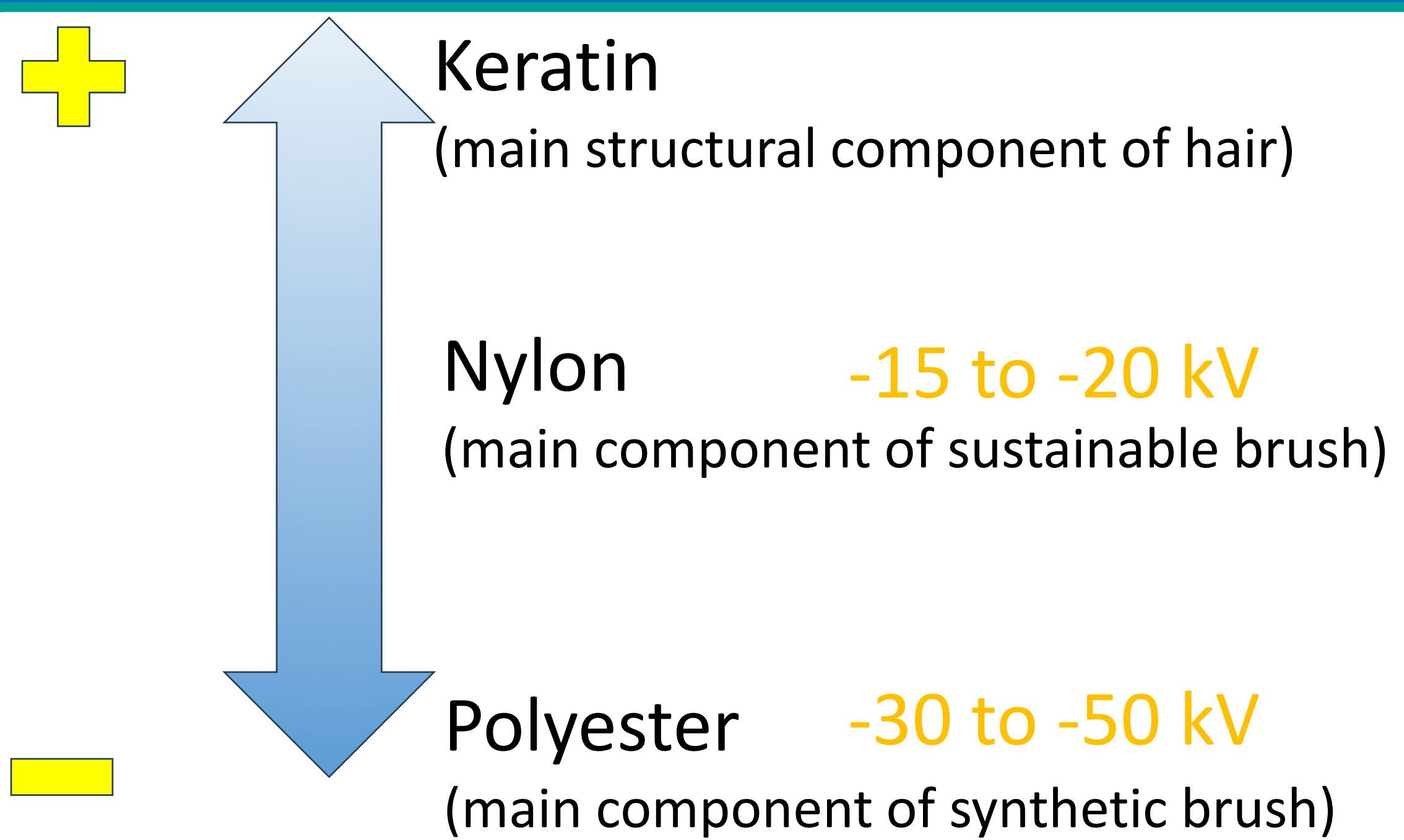
Forces applied by brush to detangle hair cause static charging by **triboelectric effect**, leading to undesirable hair frizz. Most synthetic brushes use **fossil-based thermoplastic elastomers**, while some **sustainable polymers** from renewable sources offer similar or better strength and resilience. However, their **anti-static** properties remain unstudied.

## Introduction

The project aims to study applicability of the triboelectric series and investigate the possible underlying theories for the triboelectric effect. A direct application of this is to provide guidance on developing anti-static hair-care products.

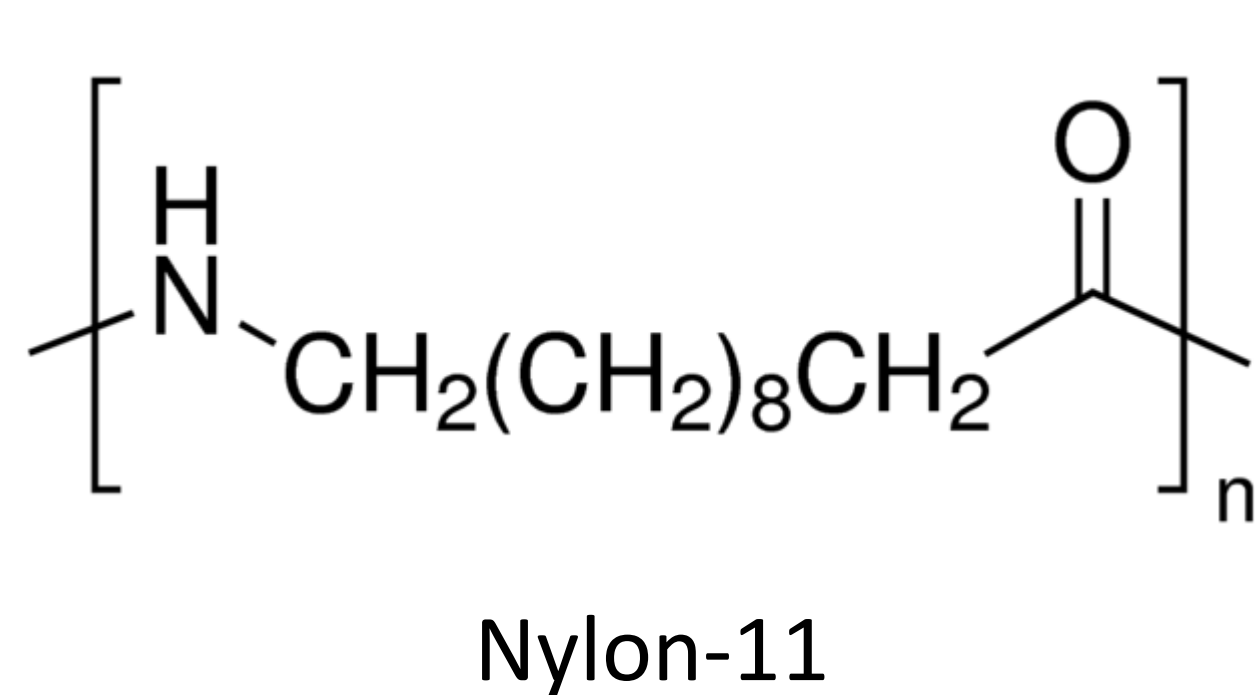
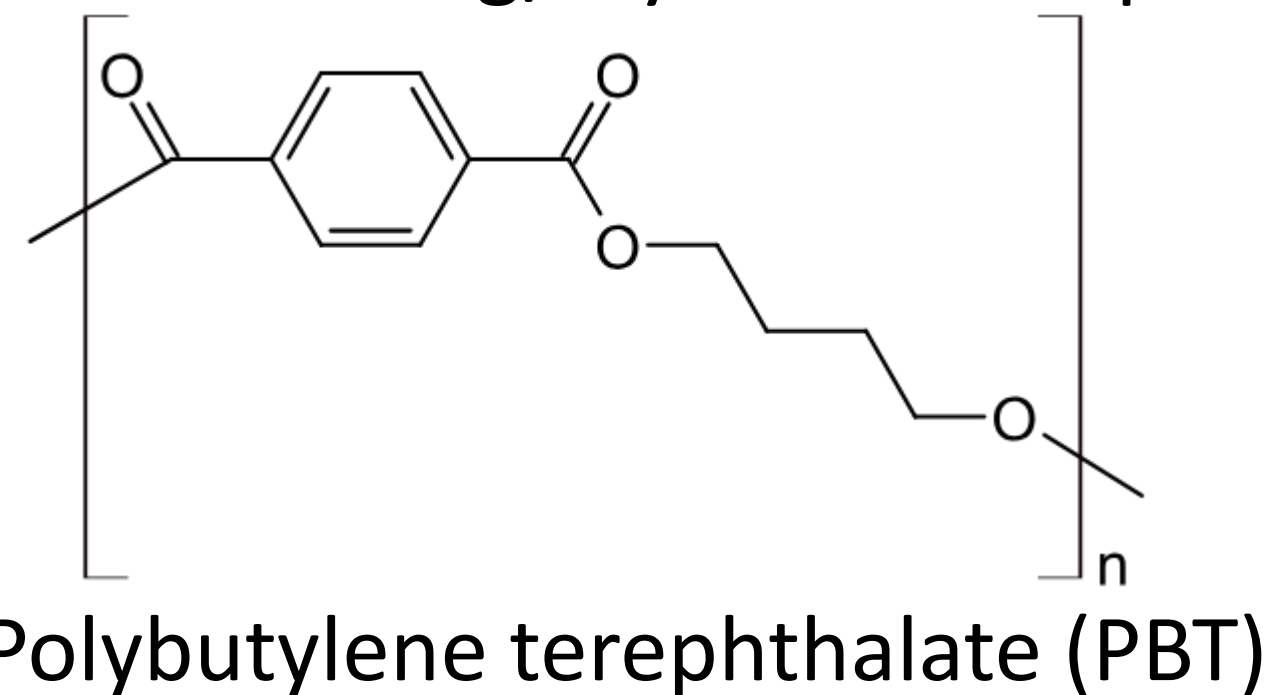


## Validation of Triboelectric Series



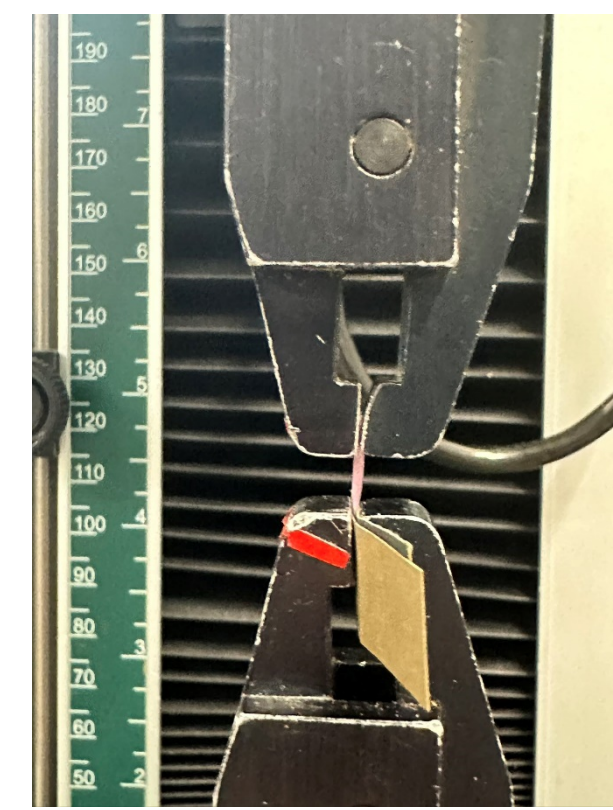
## Materials Characterisation

- FTIR: identify the functional groups.
- Simultaneous TGA/DSC: identify the glass transition temperature and melting/crystallisation peak.

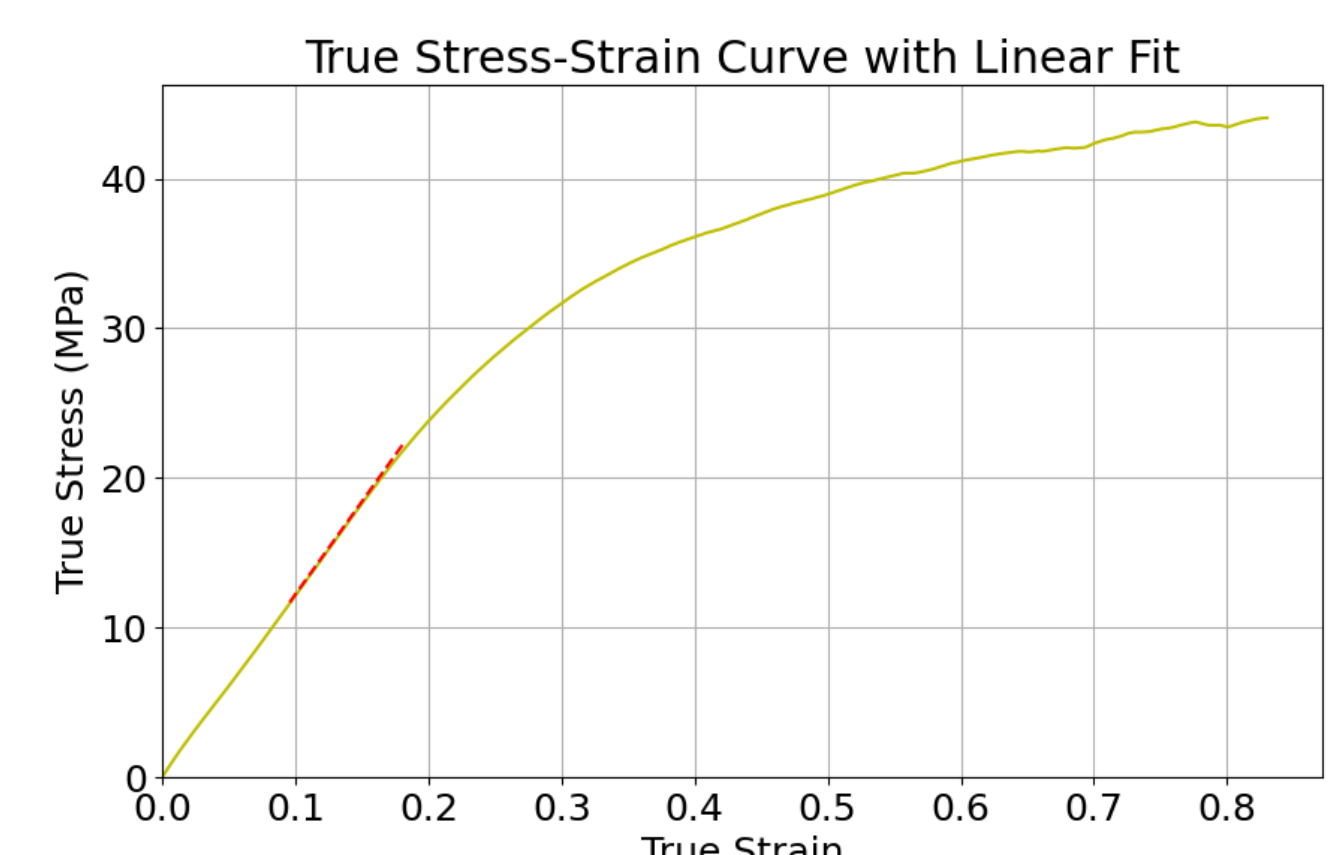
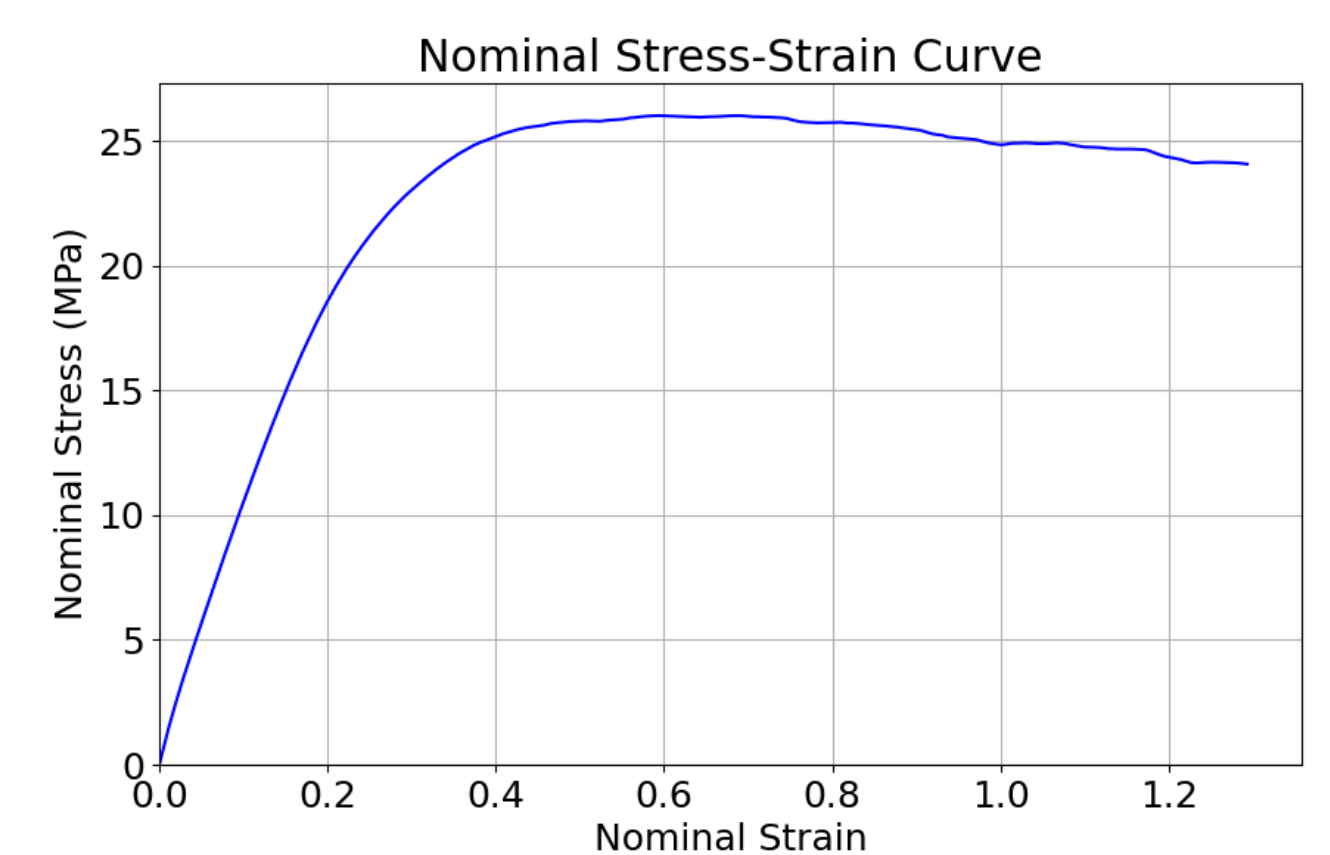


## Triboelectricity vs Stiffness

### Tensile test

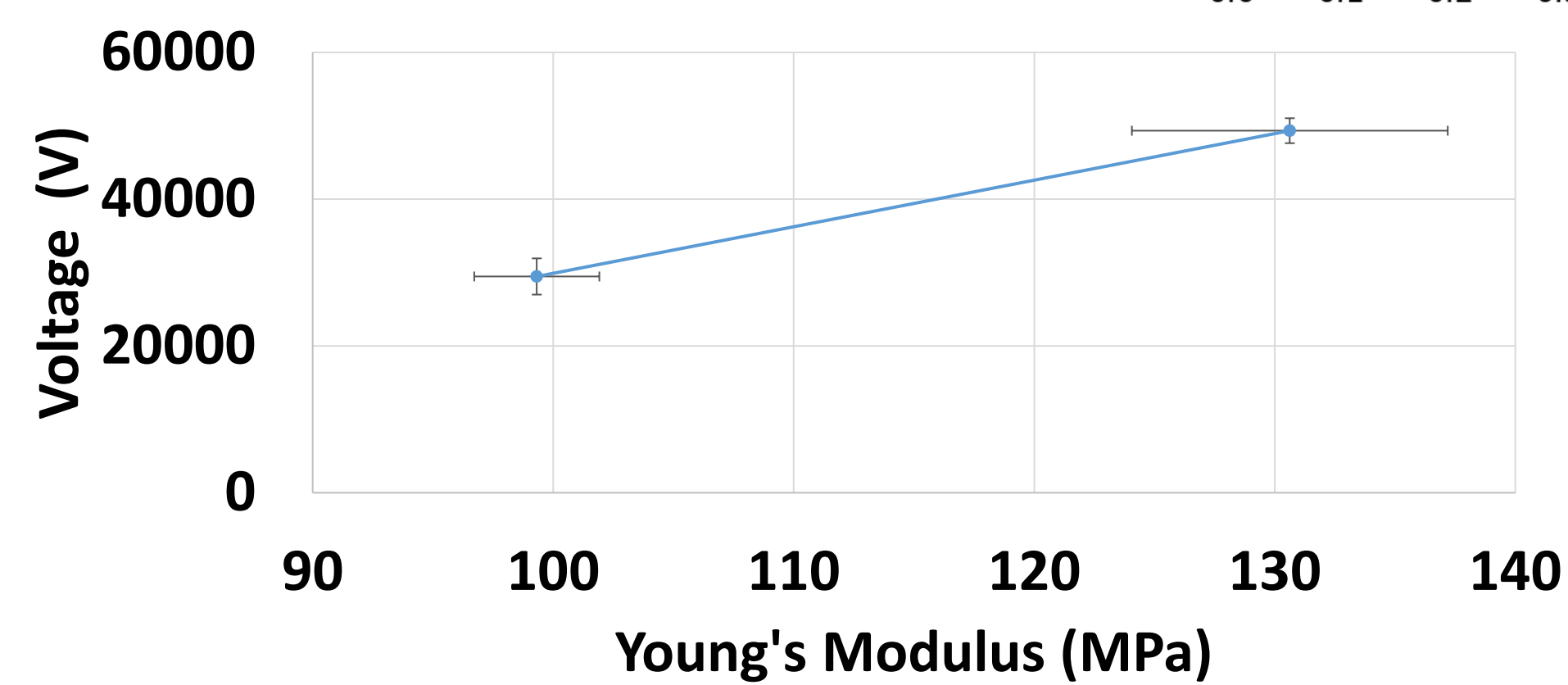


### Young's Modulus, E



Stiffness of thermoplastic Elastomers (e.g. PBT) depends on its cross-link density and Degree of crystallinity.

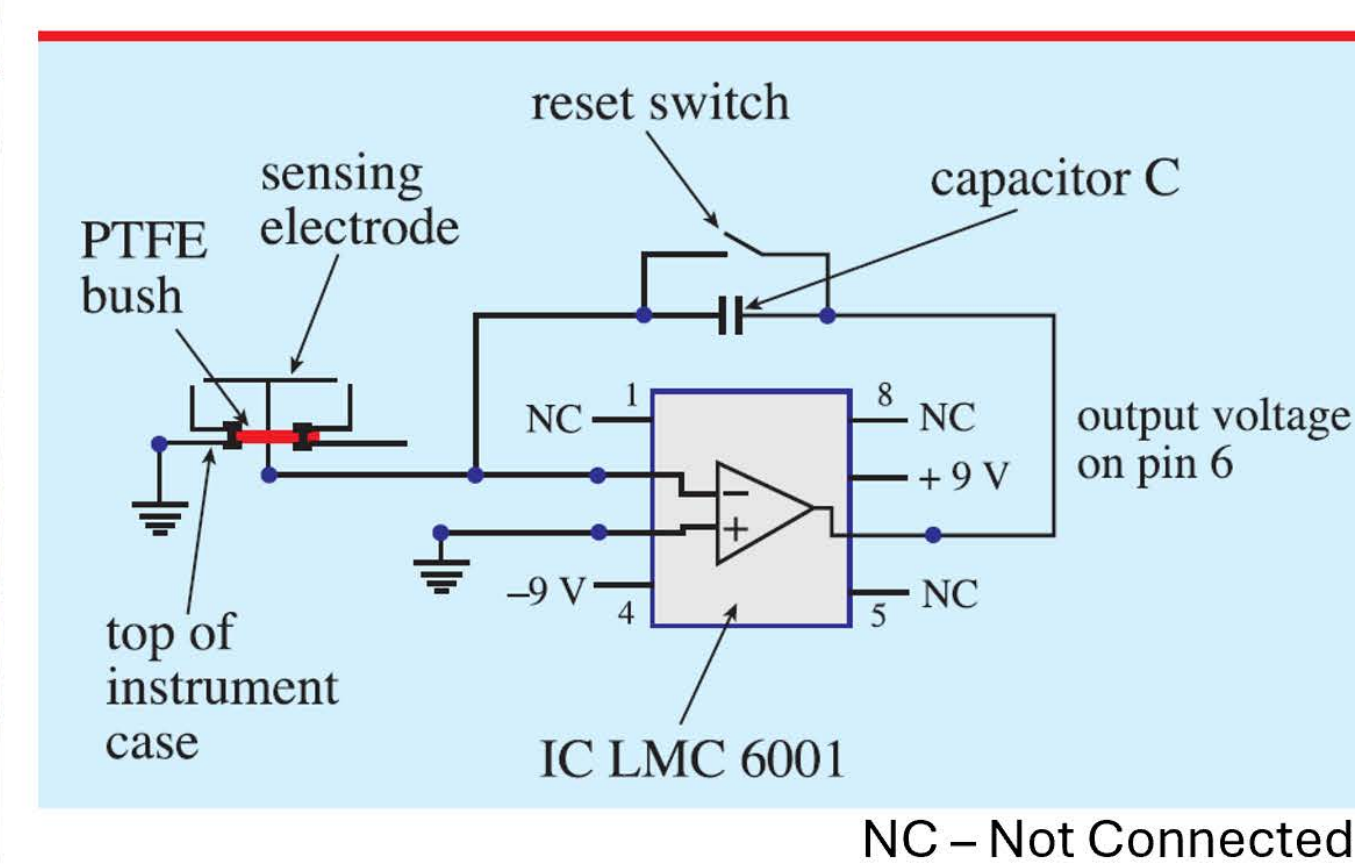
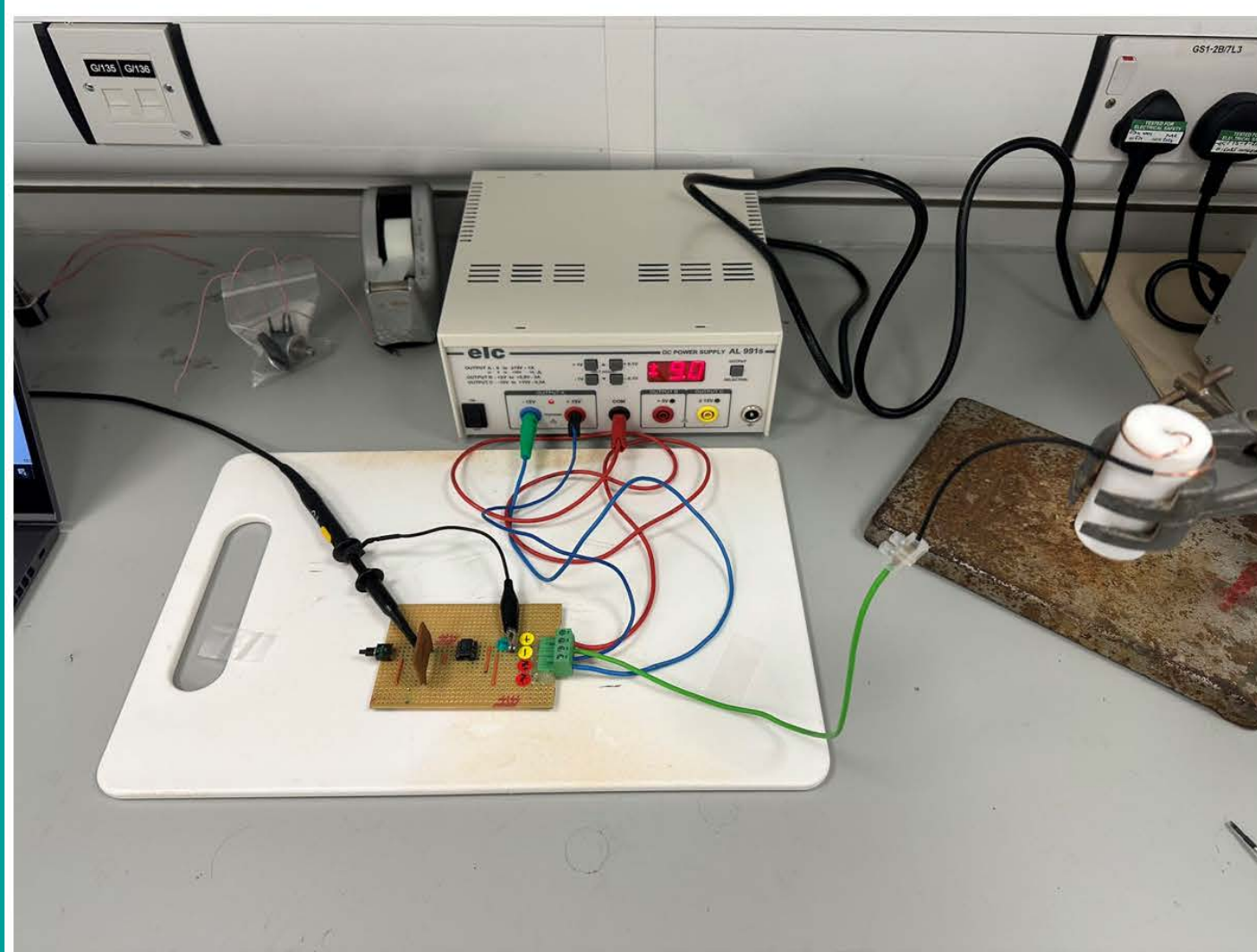
### Effect of stiffness



The **less stiff** the material is, the **less static charge** it generates because the **smaller frictional force** removes **fewer electrons** from hair.

## Measurement of Static charge

An **electronic electroscopes** [1] was assembled to measure the static charge developed from the triboelectric effect in terms of voltage.



### Piezoelectricity test:

bend the samples under 1 kg load



**< 10 mV** → **Insignificant**

### Frictional force test:

rub the samples against the referencing materials (e.g. keratin filaments)



→ **10 to 50 kV**

## Conclusion

The contribution of **piezoelectricity** to triboelectric effect is **insignificant** for bulk polymeric materials such as PBT and Nylon-11.

To minimise triboelectric effect:

- Choose a material **closer** to hair in the **triboelectric series**, e.g. nylon.
- Reduce the **frictional force** by reducing the **stiffness** of the material.

## Reference

[1] F. Thompson, Physics Education 49, 18 (2014).