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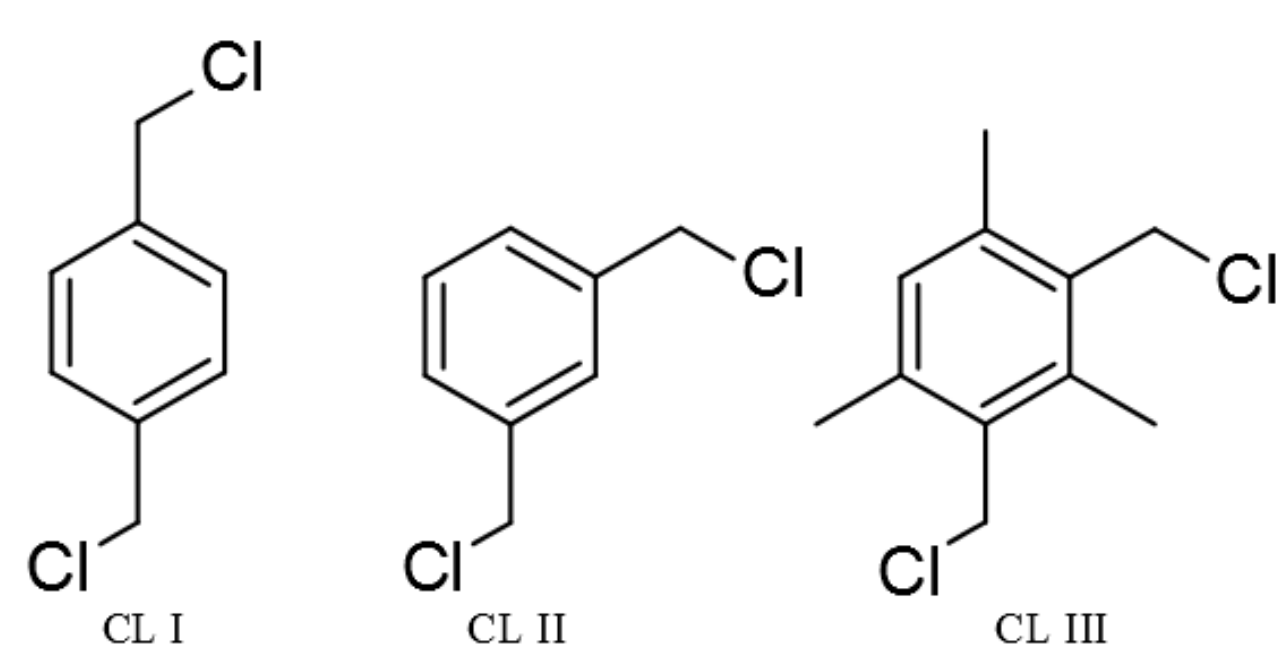
Comparative Study of the Effect of Various Cross Linkers upon Membrane Properties

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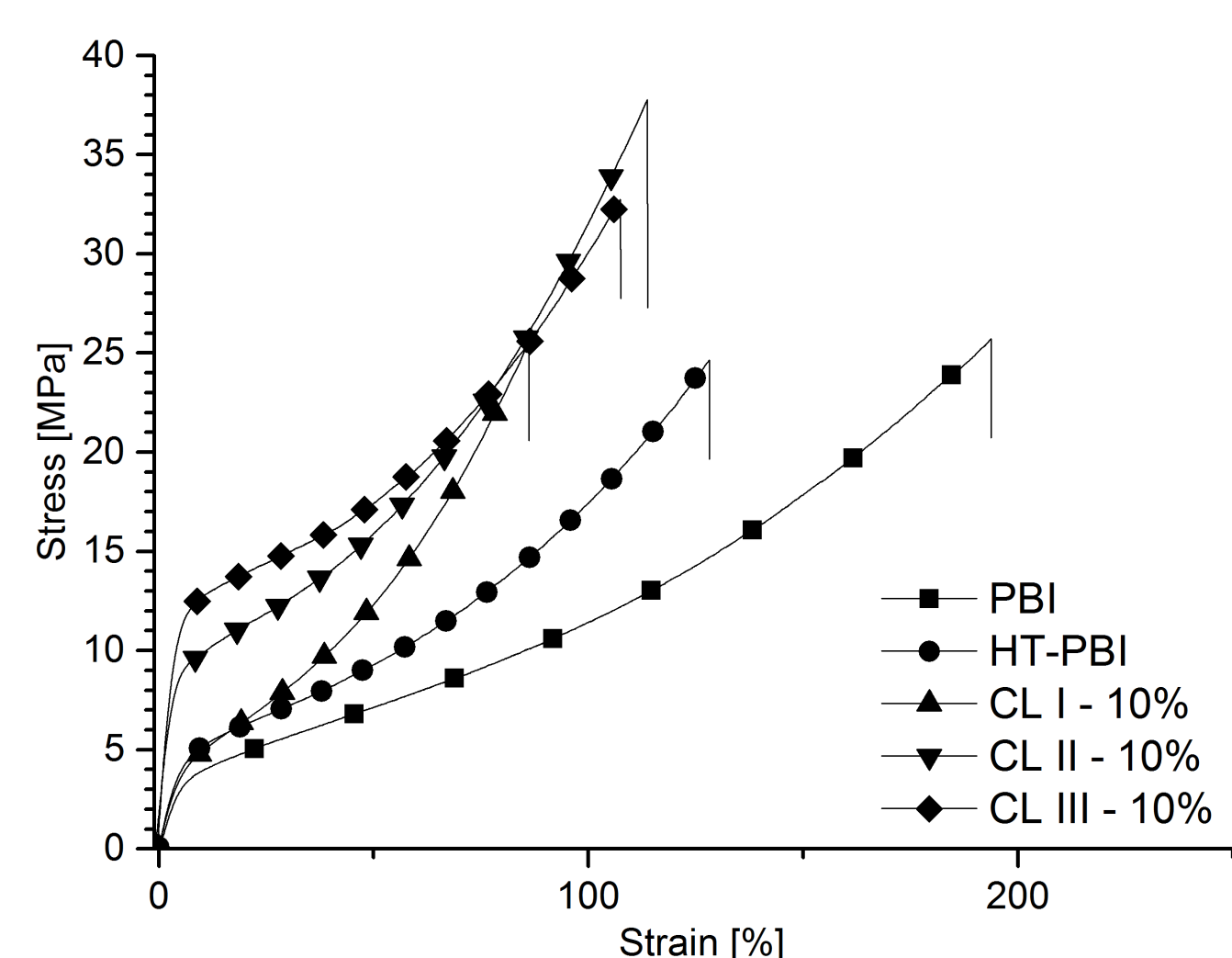
Use of poly[2,2'-(m-phenylene)-5,5'-bibenzimidazole] (PBI) is widespread within the field of high temperature (HT) polymer electrolyte membrane (PEM) fuel cells (FC), due to inherent material properties. Ionic conductivity is provided by absorbed phosphoric acid (PA), however this shows a deterioration of the mechanical properties. To reduce this, cross linking can be utilized. To investigate the extent PEM properties are affected by different cross linker configurations, three cross linking agents (CL) are chosen and a comparative study performed.

The chosen CLs are shown below. Also note that an untreated PBI reference and a heat treated PBI (HT-PBI) reference are included here.



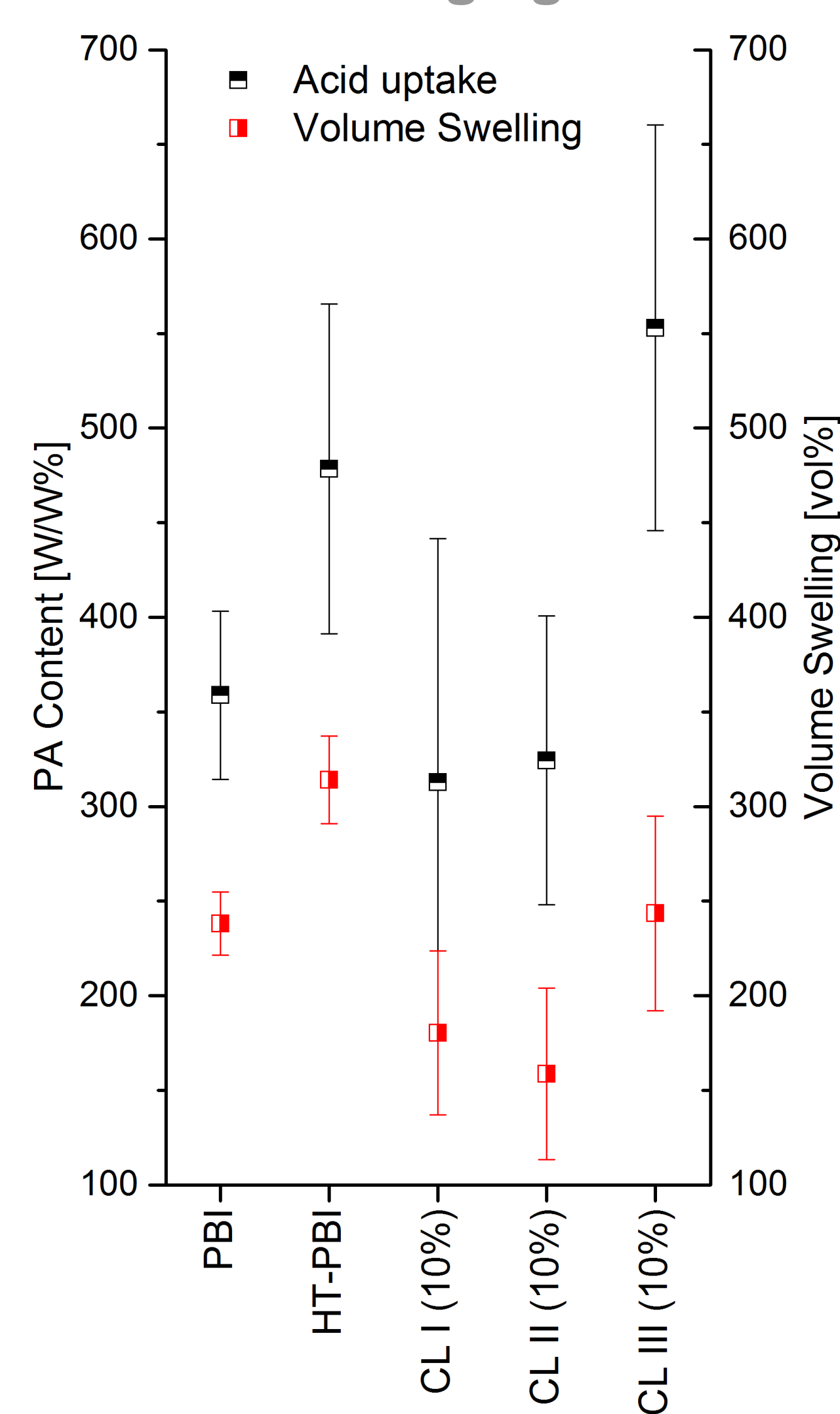
The chemical structure of the utilized cross linking agents are shown above. As shown, CL I and CL II are isomers, while CL II and CL III differs in their molecular volume.

Tensile properties are of interest to examine, since these show how the plasticity changes by changing the used CL. Stress-strain curves for doped references and 10% cross linked, are shown below. Note that highest fracture strength is observed for CL II and CL III.

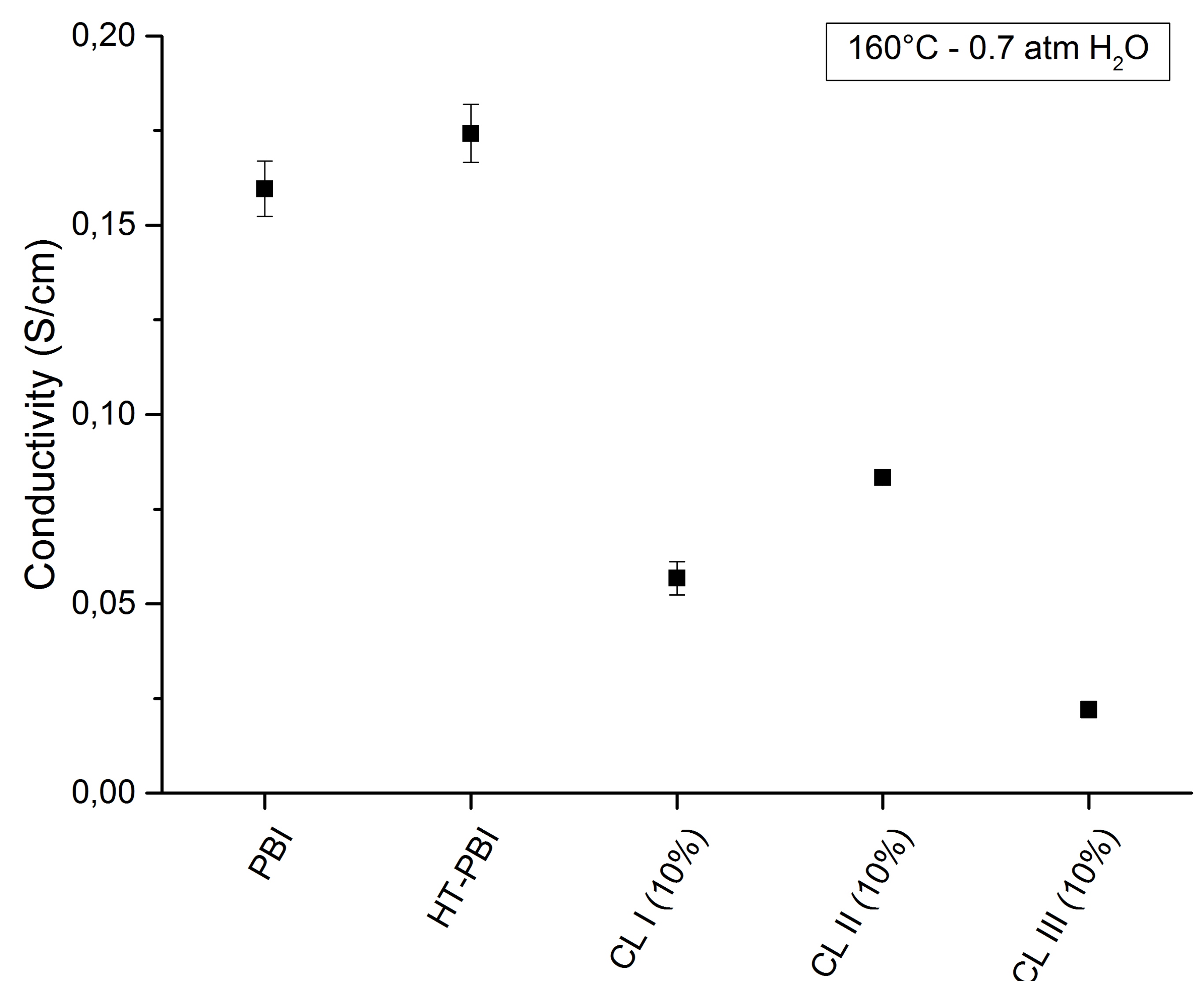


Stress-Strain curves illustrating the difference in mechanical properties between the different doped samples.

PA absorption is an important property of the membrane, considering final FC performance. Considering the graph below, it is noted that significant differences are shown. CL I and CL II shows the expected behaviour of reduced swelling and PA uptake. For CL III higher PA uptake is observed, possibly due to the molecular configuration of the cross linking agent.



The graph above shows PA absorption with responding volume swelling for the various cross linked samples. The samples are doped by immersion into 85% PA for 7 days at room temperature.



Above are shown the obtained conductivities for the samples show here. These values are obtained at 160°C under 0.7atm H₂O and averaged over 10 measurements using an in-plane, 4 probe setup.

When considering the obtained conductivity values, it is clear that highest performance are shown by the non-cross linked samples. Considering the cross linked samples, it is noted that conductivity does not follow the trend shown by PA content, but rather an inverse relation appears. This is seen by comparison of the shown relevant data. It is expected that this effect is due to the chemical configuration of the cross linking agents, where the difference between the different CLs are could be caused by changes in the conductivity pathways. This suggestion could account for the differences between CL II and CL III, where the methyl groups on CL III could reduce ion mobility within the membrane.

