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A different behaviour was found for Duraform® HST and brake fluid (Figure 5, right diagram). A positive effect of sealing can be clearly seen for Silicon coating. A reduced absorption of brake fluid (less than 0.5% after 4 weeks) is designated. But there is no significant effect for epoxy and PVC coating in case of brake fluid. For coolant in combination with Duraform® HST all sealing chemical seems to have a certain positive effect, whereas the silicon coating seems to be most effective option from the chosen solutions (Figure 5, left diagram). In summary the effect of the various coatings can be summarized as following:

- Epoxy coating:
  - massive weight increase especially for brake fluid → no sealing effect
  - negative enhancement (absorption of fluids); → additional severe delamination;
- Silicon coating:
  - less weight increase than uncoated (exception: DF/brake fluid - with delamination);
  - certain protection capability seems to be present; adhesion to be enhanced;
- PVC coating:
  - positive sealing effect for coolant but hardly no effect for brake fluid; → Optimisation possibly due to increase of coating layer thickness and the substrate/ coating anchorage;

Results and Discussion, Part 3: Mechanical Properties Testing

In addition to gravimetric evaluation, also mechanical testing was performed as an indication of the inherent properties changes. Variation of E-modulus and tensile strength were measured as representative values. Figure 6 and 7 illustrates the findings.

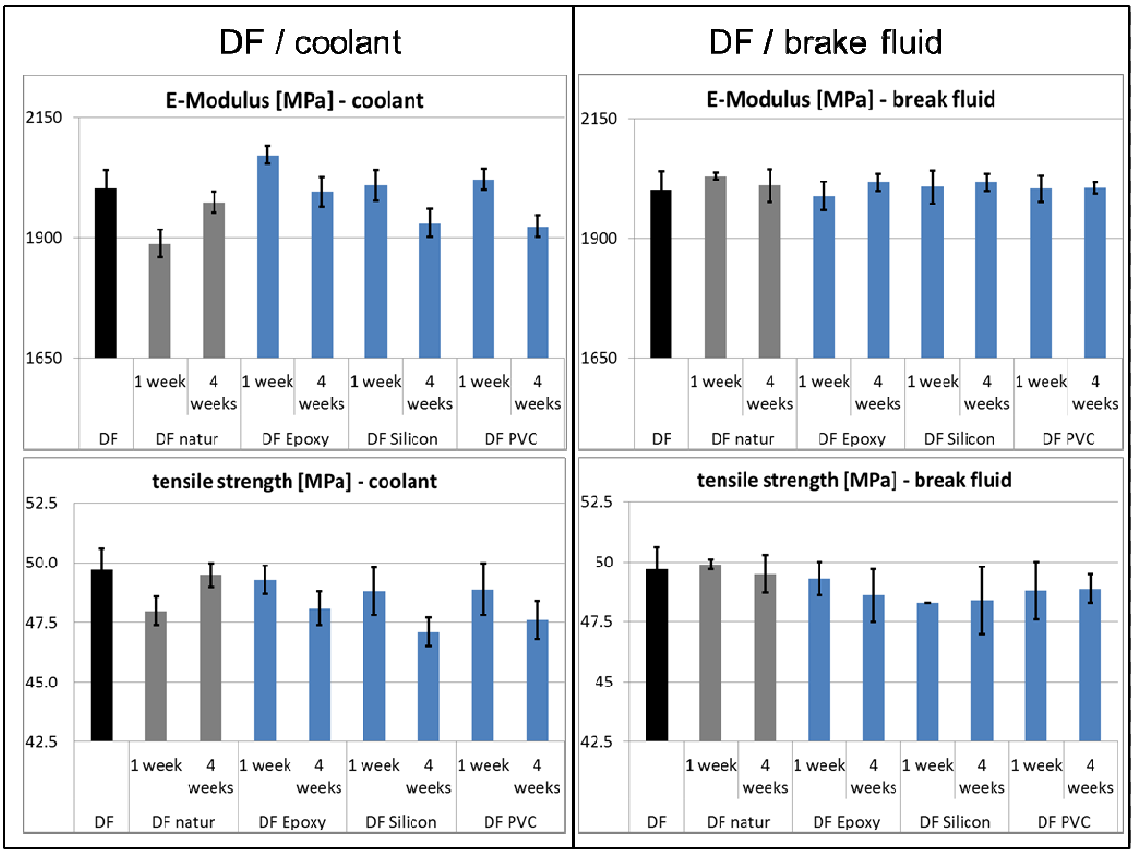

Figure 6: Change of E-mod. and tensile strength for DF in dependence of store time and coatings;

Referring to Figure 6 it is evident that the mechanical properties of Duraform® DF will not be influenced severely under the chosen conditions. Neither coolant nor the brake fluid show particular drastic alteration of the mechanical properties. An effect of coatings cannot be documented.

Somewhat different were the findings for the Duraform® HST. Figure 7 (left side) illustrates a noticeably reduction of E-modulus and the tensile strength for Duraform® HST in contact with the coolant emulsion. Regarding the brake fluid the influence is marginal (Figure 7, right side) and not at the same rate as for coolant exposure.

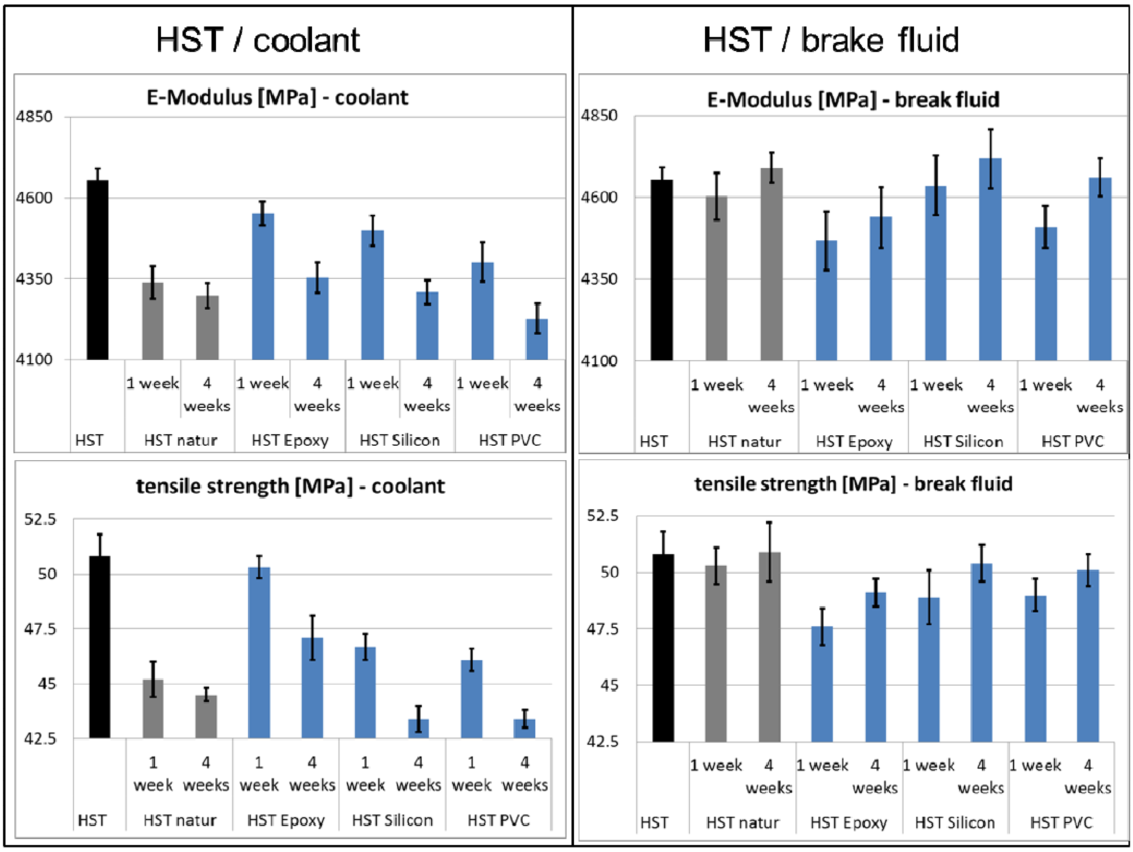

Figure 7: Change of E-mod. and tensile strength for HST depending on store time and coatings

Conclusion and Outlook

The presented work launches for the first time a systematic investigation of changes of SLS parts made from Duraform® DF and Duraform® HST in contact with car media (coolant and brake fluid). Moreover, the influence of certain sealing chemicals was evaluated as well. Overall, it can be specified that coatings on epoxy-, silicon- and PVC-basis could be successfully applied by means of dip coating. Coatings layer thicknesses between (10 µm and 70 µm) were obtained. It turned out that epoxy coatings are inadequate. A massive weight increase and delamination can be observed. Overall, silicon coatings illustrates a positive sealing effect regarding gravimetry but the adhesion to the Duraform substrates is somehow insufficient and must be improved in case of further implementation for existent car applications. PVC coatings have a marginally positive sealing effect regarding coolant. Possible improvement with increased layer thicknesses and substrate anchorage can be predicted. The overall mechanical properties investigations provide no clear indication regarding practicality of the different applied coatings. However, it is clearly recognized that coolant weakens the mechanical properties of Duraform® HST substantially.

Further investigations as to understand and improve the coating systems are necessary. The coating chemistry options can be extended to polyurethanes, fluorinated polymers and many more. In a different direction it might be also of high necessity to work on improved adhesion principles of the coatings to the substrate and film formation by cross-linking. Other car fluids used regularly (gasoline, diesel fuel, motor oils) should be investigated in similar research programs.

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