



Research Fund for Coal and Steel



**Gears with top in-service performance
developed for
hybrid and electric vehicles**

Deliverable D5.2 (D9)

Evaluation of the teeth gears distortions and study of the performance of gears working at similar conditions to those of future HEV/EV gears

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PUBLISHABLE SUMMARY

New combinations of materials and heat treatments for gears are being developed and investigated within the TOPGEAR research project.

To evaluate the material and heat treatment combinations, the first step was to characterise the surface properties on simple bolt samples (which is described in the previous reports). The characterisation of these bolt samples was carried out for different combinations of material and heat treatment. The characterisation included the determination of the surface hardness, the case hardening depth or nitriding and nitrocarburizing hardening depth and the core hardness as well as the evaluation of the microstructure and the observation of the edge oxidation. Overall, the investigations carried out showed that the required demands could not be completely fulfilled by any of the heat treatments yet. However, by adapting the process variables used in the heat treatment, it is possible to achieve the desired specifications. As an example, this was shown by means of a follow-up core hardness investigation of a single sample. The characterisation of the previous samples provided the necessary information and findings.

The information and knowledge gained with the characterisation can be used for further optimisation of the heat treatment process. Based on the results, two variants of material systems (material & heat treatment) were chosen for gear manufacturing at the WZL. As reference material a case hardened 27MnCr5 and as future EV variant a nitrided 40CrMoBi4 were used. Gears were manufactured and measured (Quality control) at the WZL, while the heat treatment was done at ALD. Before and after heat treatment, the resulting distortion is measured at CRF.

The gears were tested at the WZL under high-speed conditions ($n = 12,000$ rpm). The flank load capacity, the scuffing load capacity and additionally the tooth root bending strength on the pulsator at $f = 150$ Hz were investigated. The case hardened 27MnCr5 gears show a 20 % better tooth root bending strength than nitrided 40CrMoBi4. Flank load capacity tests of both materials show different damage types. 27MnCr5 is damaged by micropittings and 40CrMoBi4 at the same testing conditions and load level with pittings. The roughness, which could lead to micropittings, does not show any significant differences between both materials. Scuffing tests for 27MnCr5 do not lead to any damages at the maximum power of the test rig because of lubricant strength.