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A SIMULATION OF POLYMER GEAR CONTACTS WITH SHRINKAGE EFFECTS

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ABSTRACT

The present research work will concentrate on the effect of shrinkage on PEEK gear contact behaviours. The advanced non-linear Finite Element Method will be employed to the research work to understand the gear contact stresses and deformations for both theoretical gear geometry and true geometry due to the shrinkage.

Keywords: polymer gears, contact stresses.

INTRODUCTION

Polymer gears have unique advantages over metal gears: low cost and weight, high efficiency, quietness of operation, functioning without external lubrication, *etc*. For example, up to 70% reduction in mass, 80% reduction in inertia and up to 9% consumption reduction have been reported using PEEK gears instead of metal gears (Ferfecki and Hale, 2011 and Snyder, 2010) in automotive engineering. It is well known that PEEK has unique mechanical properties for gear applications, e.g. high retention of mechanical properties at elevated temperature, and low wear rate as well as low creep behaviour. PEEK gear applications have been considered from low-power, precision motion into more demanding power transmission needs in challenging environments such as automotive engineering and precision medical devices. PEEK machine elements will enable key developments in low-cost and energy efficient personal transport for the world's emerging economies (e.g. electrical vehicles).

As for all polymer gears, much benefit is derived from the use of the injection moulding process, which allows cost effective production and short lead times. Unlike the machining of precision steel gears, where each gear is manufactured to a tight tolerance, injection moulding of polymer gears requires accurate dimensional tolerances on the mould tool and a full understanding of the injection moulding process including the effects of shrinkage.

RESULTS AND CONCLUSIONS

Fig.1 shows a real PEEK gear tooth profile using micro-CT measurement technique with a accuracy of 5 μm. The present research work will concentrate on the effect of shrinkage on polymer gear contact behaviours. The advanced non-linear Finite Element Method will be employed to the research work to understand the gear contact stresses and deformations for both theoretical gear geometry and true geometry due to the shrinkage. The initial results show the effect of shrinkage on the gear contact stress is significant. As shown in Fig.2, the PEEK gear local contact stress has increased by almost a factor of two for only 1.5% dimensional shrinkage while the contact locations have also changed. These theoretical results

will be contextualised with experimental data on moulded gears with known dimensional tolerance variations.

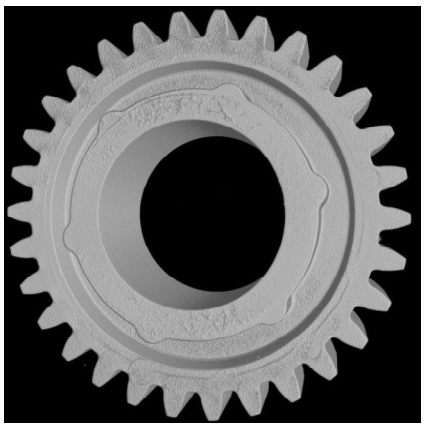
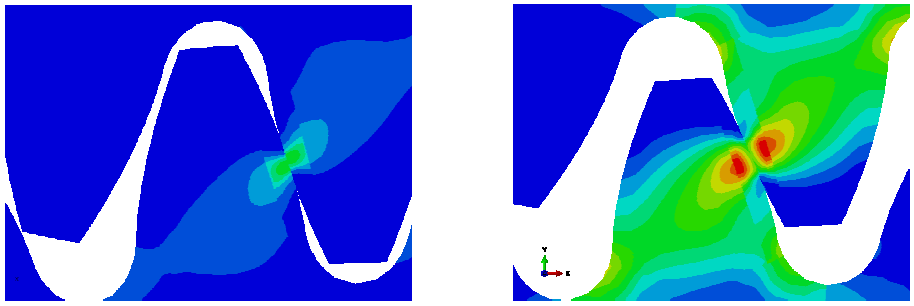


Fig.1 - PEEK gear profile after injection molding



(a) Without shrinkage (b) with shrinkage

Fig. 2 - Shrinkage effect of PEEK gear contact stresses

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