

國立中央大學

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碩士論文

基於蝸桿創成磨齒加工之齒面磨削紋理模  
擬及控制方法

Machining simulation and Control Method of  
Ground Texture on Gear Tooth Surface Based on  
Continuous Generating Gear Grinding

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# 摘要

標準蝸桿砂輪創成磨齒(generating gear grinding)運動多產生沿齒長方向、相互平行之磨紋，相較於經珩齒(gear honing)後之交錯、亂序齒面磨紋，已被證實不利於降低齒輪之嚙合噪音；而國外創成磨齒機已具備磨削無規律磨紋之技術，然基於商業考量未公開揭露，若可掌握此技術將有助於提升國內機台及加工齒輪之附加價值。本研究建立真實具磨粒之蝸桿砂輪模型、依據實際蝸桿砂輪磨齒機之多軸同動，建立數值方法模擬出具有磨削紋理之齒面，並有系統地分析幾何參數與機台運動參數對齒面磨紋及齒面粗糙度之影響，研究結果表明，齒面粗糙度隨齒輪軸向進給速度上升而增加、齒面上不同位置之磨紋具有相似性，磨料粒徑愈大則齒面粗糙度愈大、齒輪螺旋角與砂輪半徑對齒面粗糙度影響較不明顯。此外，提出四種不同波形之附加運動以控制齒面磨紋。範例中，標準機台運動之模擬齒面紋理為直條狀、具附加運動之模擬齒面紋理具有亂序交叉紋，且最大磨紋深度改善10%，並與真實齒面量測結果趨勢一致，本文建立技術將可提升國內磨齒機附加價值，改善加工齒輪之傳動品質，為日後磨紋研究提供理論依據。

**關鍵字：**蝸桿砂輪、創成磨齒、磨紋、磨齒機、表面粗糙度

# ABSTRACT

Traditional machining method of a CNC generating gear grinding machine usually generates regularly-parallel grinding texture (RPGT) on gear tooth surface, which is disadvantageous to gear meshing noise comparing to irregularly-staggered grinding texture (ISGT). The technology to form ISGT is commercially confidential so far. In this study, a grinding wheel with abrasive particles is numerically constructed by programming to perform grinding simulations and generate grinding marks based on a multi-axis CNC generating grinding machine. Surface roughness of the finished gear is also estimated. As simulated results show, the surface roughness increases as the axial feed velocity of gear increases, microstructure of the grinding texture is similar at different positions on a gear surface, the surface roughness is improved with the smaller abrasive grit size, and the surface roughness is insensitive to the helical angle of gear and the diameter of grinding wheel. In addition, four types of oscillating waves are added on the axial feed of gear to adjust the grinding textures. It is proven that the ISGT can be obtained by applying the additional motions and the maximum grinding depth is reduced by 10%. This result is consistent with the practical results published by a well-known manufacturer, Reishauer.

**Keywords:** Cylindrical Gear, Grinding Wheel, Generating Grinding, Grinding Texture, Surface Roughness