



輪胎成形模具表面 抗沾黏特性研究

Study of Anti-Sticking Characteristics
of Tire Mold Fabricated
by Pulse Magnetron Sputtering Process

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摘要(Abstract)

隨著汽車工業飛速發展，輪胎的產量越來越大，輪胎技術水準越來越高。20 世紀以來，國外大型輪胎公司開發節能、無污染、高速、安全、耐用等綜合性能優異的高性能輪胎，其中最典型的輪胎為綠色輪胎。這類高性能輪胎的最大特色是同時具有低滾動阻力、高抗濕滑性能和高耐磨性能，因此對輪胎材料的要求更高。模具是輪胎

等橡膠製品生產必需的重要工具，它在使用過程中不可避免地要受到橡膠、配合劑以及脫模劑的綜合沉積污染(主要污染物是硫化物、無機氧化物、矽油及炭黑等)，反復使用會形成一些花紋污染區，所以，必需經常性地清洗模具以確保其表面的潔淨度，從而保證輪胎的質量以及模具的壽命，此外等橡膠製品在生產過程中常出現脫模困難、生產效率低、表面光潔度不易掌控等問題。

本研究利用直流磁控濺鍍法在輪胎成形模具鋁材 6061 上沉積鉻基鍍膜並加入耐高溫、抗沾黏如鎢、鋁等格系原子並通入反應性氮等氣體，利用 SEM、GID-XRD 以及 TEM 對薄膜的表面形貌、晶體結構及化學鍵結進行分析，最後再以熱反覆實驗測試鍍膜的熱穩定性。結果顯示，鉻基鍍膜能有效提升輪胎模具在 200°C 下之性能穩定性，經過線上實測在 200°C 溫度下，熱反覆實驗達



100 次不需使用玻璃性潤滑劑，可提升稼動率及產品品質。

The rapid development of the automotive industry has increased production of tires and has accelerated the development of tire technology. Since the turn of the twentieth century, many large foreign tire companies have developed high-performance tires with outstanding comprehensive qualities, especially in terms of energy-saving, non-pollution, high-speed, safety, and durability. Among the high-performance tires, the most representative should be green tires. The prominent features of high-performance tires is their low rolling resistance, high wet skid resistance, and high wear resistance at the same time, which therefore requires better tire materials. Mold is an important instrument essentially necessary for producing rubber products. During the production process, the mold is inevitably contaminated by the comprehensive deposition of rubber, complexing agents, and release agents, with their sulfides, inorganic oxides, silicone oil, and carbon black as the main pollutants. Because repeated use causes patterns of contamination on the mold that must be cleaned on a regular basis so as to ensure the cleanness of its surface, thus guaranteeing the quality of the tire and the durability of the mold. Additional problems in the process of producing rubber products include the difficulty of releasing the mold, inefficient production, and difficulties in controlling the surface finish.

In this study, the method of direct current (DC) magnetron sputtering was used to deposit a chromium (Cr)-based coating on the aluminium 6061 of the tire mold, adding such high-temperature resistant and anti-sticking elements to Cr compounds, such as tungsten and aluminium, as well as placing reactive nitrogen and other gases. The effects of SEM, GID-XRD, and TEM on the surface morphology, crystal structure, and chemical bonding of the coating film were analyzed. Lastly, heat was used to test the thermal stability of the coating and repeated experiments. The experimental results show that Cr-based coatings can effectively improve the stability of tire mold performance at 200°C. In the actual tests with up to 100 times of repeated experiments at 200°C, the coating was still effective without glass lubricant, which proved] that this coating method can improve utilization rate and product quality.

1. 前言

常見的輪胎成型作業採用射出成型法，將混合膠料在壓力下射入模具後固化成型，以 150-200°C 固化，工作溫度大約在 200°C 附近進行，在此高溫下橡膠已為熔融狀態，此時橡膠會軟化沾粘在模具表面上，造成模具的沾粘問題，為克服此問題，除了適當的模具設計外，模具材料的選用及模具表面的鍍膜選用也是改善作法，但無論何種選項皆會影響尺寸和表面精度，及模具的使用壽

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