

# 化學方法製備鎳奈米顆粒及鎳薄膜於軟性聚亞醯胺基板上 與特性研究

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## 摘要

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近幾年來由於 FPC (軟性印刷電路板)具有可撓性，並且廣泛應用於資訊、通訊及消費性電子產品，然而，舊有 FPC 製程為銅壓合製程或是真空濺鍍銅再去電鍍銅的製程，這些方法，不僅會有銅擴散到基板的問題，不然就是會有成本或製備時間的問題。本論文研究主要致力於利用完全濕式化學的製程，經由 KOH 鹼的表面處理、金屬鎳離子的交換及化學還原劑的金屬還原，以低成本的方法製備鎳奈米顆粒於聚亞醯胺膜的表層，再利用鎳奈米金屬顆粒的活性，去進行 50℃ 低溫的鎳無電解電鍍即可簡單製備出一系列的表面金屬化的聚亞醯胺膜。此一系列試片經由 ATR-FTIR 分析表面的化學變化，XRD 分析金屬化過程的結晶變化，contact angle 分析表面處理的最佳程度，four point probe 分析金屬化過程的表面電性，TGA 與 DSC 分析試片所需的 PAA 閉環及金屬結晶之熱處理溫度，AFM 分析還原出來的鎳奈米金屬在表面的型態，FE-SEM 分析鎳無電解電鍍後的表面型態及 TEM 分析試片截面的金屬分佈型態。由 TEM 可以觀測出此鎳金屬薄膜約為 300 nm。然而此 Ni-NPs/ PI films 與 Ni/ PI films 表面金屬薄層的表面電阻分別為  $1.6 \times 10^7$  與  $0.83\Omega/\text{cm}^2$ ，特別是 Ni/ PI films 有良好的導電性。在鎳與聚亞醯胺的接著力方面，經由百格測試(ASTM D 3359-95: with Scotch 610)，也沒有任何的表面破壞。所以此表面鎳金屬化的聚亞醯胺可以有效作為往後直接電鍍銅的無膠系銅箔基板(2L-CCL)之前驅材料。

# Chemical Formation of Ni nanoseeds and Ni thin layer on Flexible Polyimide Film

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## Abstract

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Flexible polyimide (PI) films are successfully surface-nickelized by a fully solution-based process and have excellent adhesion between polyimide and nickel phases. The polyimide substrates were modified by using the alkaline hydrolysis, ion exchange, reduction and nickel electroless deposition processes. All products were characterized by ATR-FTIR, XRD, contact angle, four point probe, AFM, FE-SEM and TEM measurements. Atomic force microscopy and field emission scanning electron microscopy were used to follow the growth of the nickel nanoparticles (Ni-NPs) and nickel films on polyimide surface. The surface resistance of the Ni-NPs/ PI films and Ni/ PI films, measured using a four-point probe, were  $1.6 \times 10^7$  and  $0.83\Omega/\text{cm}^2$ , respectively. The TEM was used to understand that the thickness of nickel particles thin layer was 300 nm on polyimide surface. The nickel thin films are highly adhesive on PI and readily pass the Scotch-tape test (ASTM D 3359-95: with Scotch 610) without any failure.