Electroplating of Nickel and Copper Layers on Nanoengineered Plastics

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Introduction

➢The motivation for this project is the development and proposed use of novel nanoengineered polymeric materials in many industrial and commercial applications. This necessitated the development of a robust metallic coating that can withstand aggressive environmental conditions.

➢This research explores the methods of electroplating nickel and copper to the substrate, including the effects of various duty cycles and cathode current density

Nanoengineered Plastic

Figure 1: Nanoengineered polymeric wafer

➢The nanoengineered polymer resin provided by SABIC is in the form of polymeric beads (~ 1 mm dia).

➢Using elevated temperature extrusion and compression molding, the beads were formed into sheets with a nominal resistance of 1000 ohms, then cut into circular wafers, as shown in Figure 1.

Experimental Procedure

➢In this study Copper and Nickel are electroplated using pulse plating technique, as shown in Figures 2 (a) and (b) respectively

➢ Copper Acid and Nickel Sulfamate are utilized as the bath electrolyte solutions, respectively.

➢Pulse deposition occurred at varying duty cycles including 25%, 50%, 75%, and 100% (DC deposition)

➢Cathodic current density is kept constant at 10 mA/cm^2 with an average film thickness of ~ 15 μm.

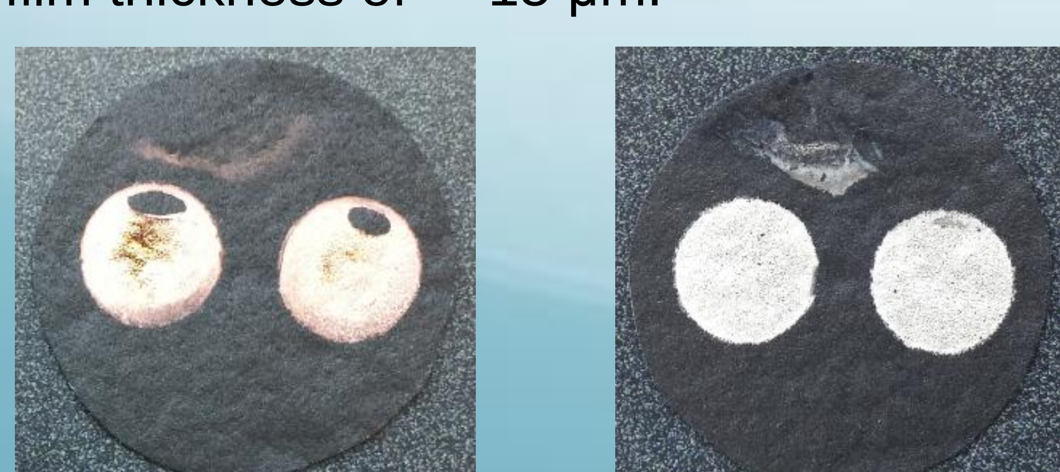
(a)  (b)

Figure 2: Electroplated (a) Copper (b) Nickel layers

Results

➢Samples are examined using Scanning Electron Microscopy (SEM) with a Philips XL30 FEG SEM at 50X mag .

➢Figure 4 presents images used to compare the plated film surface morphology characteristics for copper and Nickel layers.

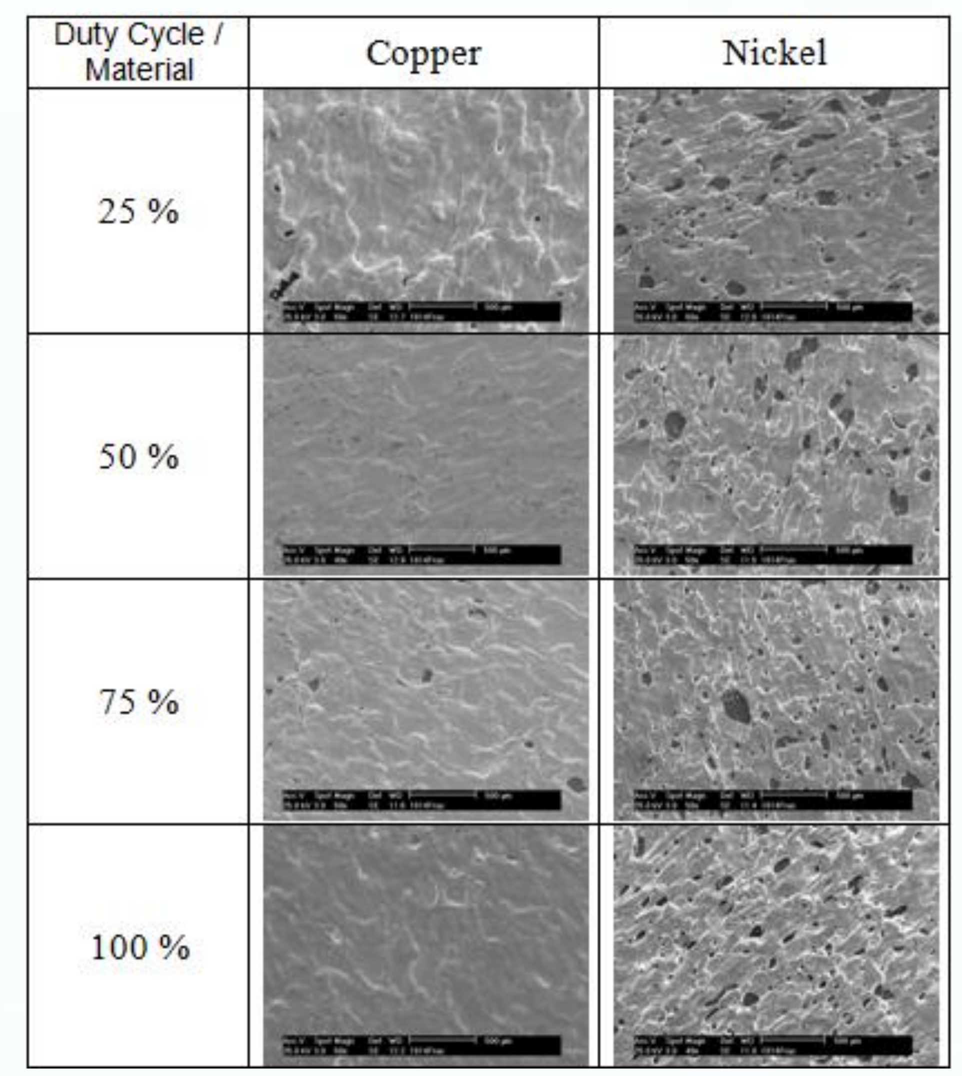


Figure 3: SEM Imaging of Copper and Nickel Film Surface Morphology

➢Mechanical Properties are measured using nanoindentation using CSM Nanoindentation Tester with a Diamond Berkovich Tip.

➢Linear program profile implemented, Figure 4(a), with a loading and unloading rate of 25 mN/min at a maximum depth of 1000 nm. Resulting indent captured in Figure 4(b).

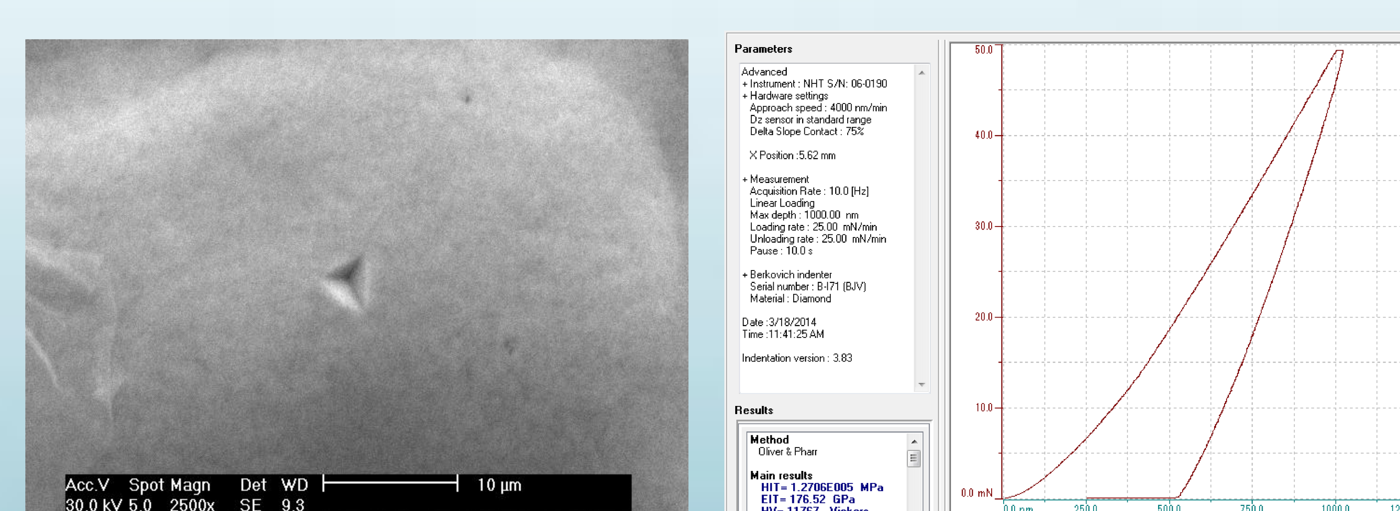
(a)  (b)

Figure 4: (a) SEM image of a typical indent on copper film (b) An indentation Profile obtained for this film.

Conclusions

➢As shown in Figure 3, Copper exhibits a less porous deposit

➢Copper deposits were found to have prominent grain growth on the order of 500 to 2000 nm, whereas nickel displays a smooth, featureless topography

➢For both copper and nickel; Young's Modulus tends to increase with an increase in duty cycle, Figures 5 and 6, respectively

➢On average Copper films results in a 60% higher Young's Modulus then Nickel

➢On average Nickel films results in a 115% higher Hardness then Copper

➢Independent testing determined a nominal adhesion force of 25 N for these metallic films

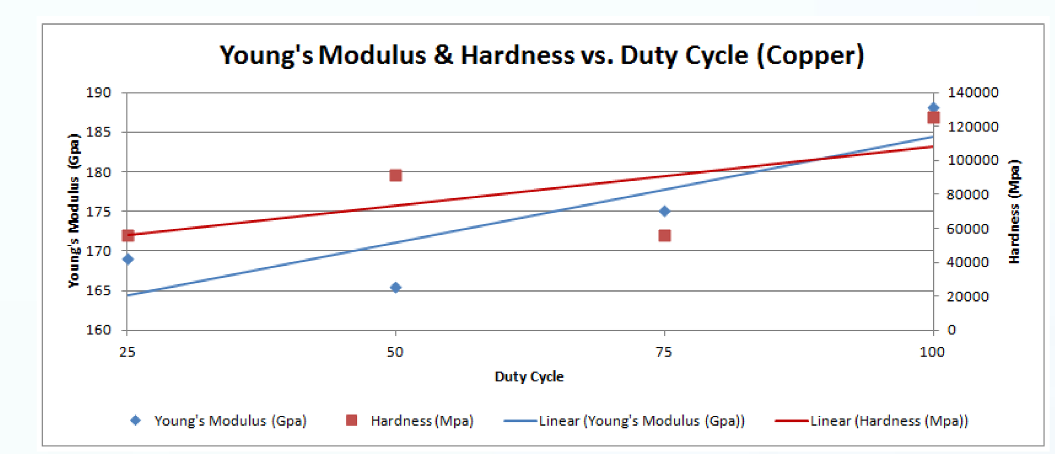


Figure 5: Young's Modulus and Hardness plotted against various Duty Cycles for Copper films

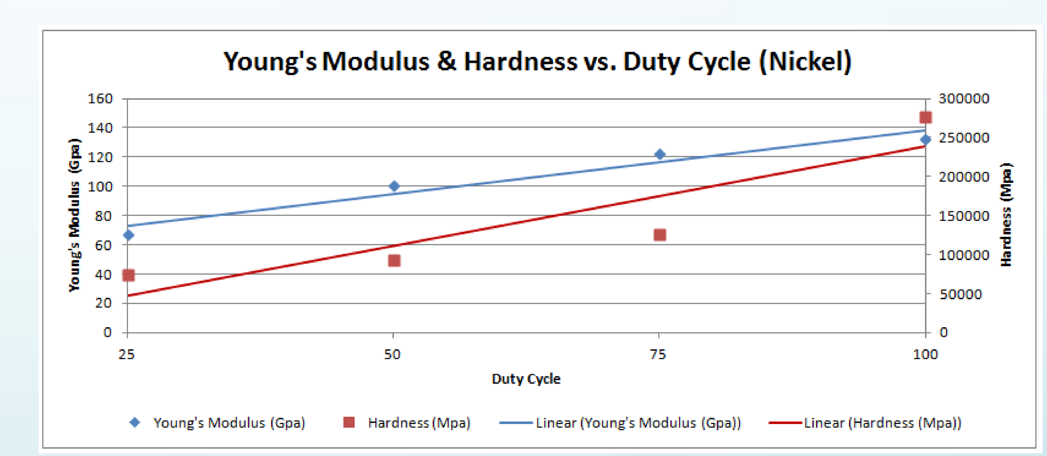


Figure 6: Young's Modulus and Hardness plotted against various Duty Cycles for Nickel films

Acknowledgements

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