Mechanical Design of Real-time Substrate Transport Control for Stable and Efficient Thin-film-based Roll-to-roll (R2R) Micro-nanomanufacturing

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The commercialization of electronic devices requires the high efficiency and stable mirco-nanomanufacturing processes that allow frequent design upgrades. R2R Nano is a gateway to science and engineering research that aims to impact the widespread adoption of R2R technologies for low-cost, high-volume production of high technology products on flexible substrates. However, there are lots of the mechanical and chemical factors influencing the system performance when fabricating nano-scale structures. Thus, feedback control system is increasingly playing a great role in improving the R2R performance.

The aim of my work of the project is more related to design mechanical section of the whole feedback control system for enhancing the performance of the R2R system by harmonizing between the moving speed of substrate, film surface energy and substrate's tension. In this project, a roll of thin-film with several microns thickness is used as substrate which allows lower process cost and surface quality but also make the substrate transport more challenging than working with much thicker substrate. The mechanical system design mainly consist several subcomponents such as the roller geometrical structure, thin film substrate tension sensor, two servo motors and nano-patterned liquid dispenser. As a result, the mechanical system of the control scheme will allow fabricating uniform nanostructures over a large area at a desired throughput.

Based on the improved R2R mechanism, multi-processing can be developed such as imprinting, LWD (laser induced direct-writing) and coating.