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# Performance assessment of a low-cost spinner design

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**Abstract:**

Resist-based lithography require the application of a layer of sacrificial resist for lift-off, etch masking or similar processes. Typical clean-room based resist spinners are expensive, and being situated in a clean room places strict requirements on sample cleanliness and materials compatibility. As a result, there is a strong need for low cost spinner systems outside of traditional cleanroom environments for development and fast device prototyping purposes. Such systems would enable application of thin resist layers for microfabrication prototyping in the academic, educational and hobbyist communities, with a low-cost barrier for entry.

Here, we present a spinner design with full PID and feed-forward speed control and vacuum chuck wafer holding, based on 3D printed parts, repurposed commercially available bearings from a washing machine and driven by widely available brushless motors from remote control cars and aeroplanes (Figure 1); thanks to developments in drone technologies, the cost of such motors is dropping while the quality, availability and options are increasing. This spinner is capable of spinning 6” wafers from 1000 rpm up to 10000 rpm with better than 1% error on the set point (Figure 2). We have benchmarked the resist thickness and uniformity obtained with this design against a commercial cleanroom based spinner using ellipsometry and a novel optical microscopic colorimetric technique (Figure 3).

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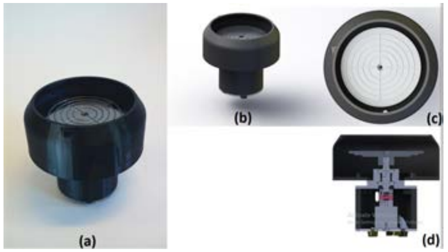


Figure 1: Real life image (a), rendered 3D view (b), rendered top view (c), and rendered cross-section view (d), of the designed spinner.

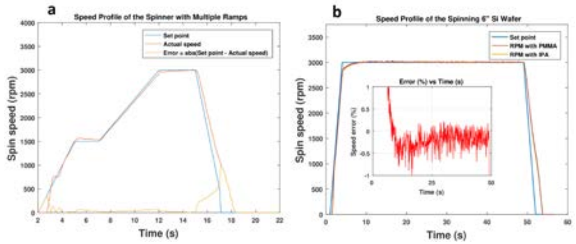


Figure 2: (a) Speed profiles of the designed spinner with PI and Feed Forward controllers. (b) Speed profile of the spinning 6" Si wafer. The inset shows the speed error (%) during the spinning PMMA.

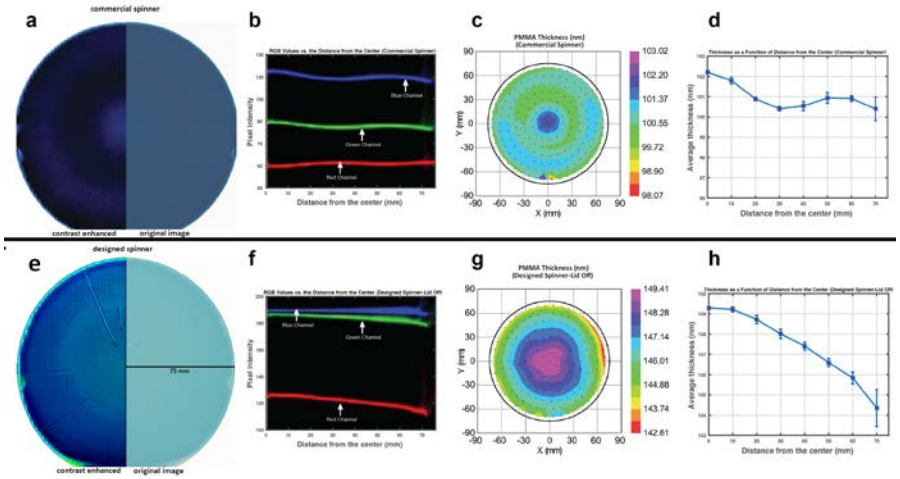


Figure 3: Top: (a) Optical microscope map of the PMMA coated silicon wafer using a commercial spinner; the left half is the contrast enhanced of the original image on the right half. (b) Calculated RGB values of the resist as a function of the distance from the center. (c) Ellipsometry color map of the resist thickness (nm) vs. position. (d) Calculated average PMMA thickness (nm) as a function of the distance from the center. Bottom: (e,f,g,h) The corresponding calculated values of the PMMA using the designed spinner.