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Optical guiding mechanism for the next generation of fully-motorized tip-scanning AFMs

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Tip scanning AFMs have several advantages, namely the ability to investigate samples of unrestricted size or weight as well as an unobstructed optical view from below. This is crucial for biological samples, where correlation with optical microscopy techniques is frequently needed. However, conventional optical beam deflection (OBD) is very challenging to effectively integrate into a tip-scanning architecture, limiting the number of existing tip-scanning AFM designs. The OBD adjustment mechanics are a crucial component affecting both ease of use and imaging performance. The trend towards fully automated instruments adds to the challenges for a tip-scanning design, since large and heavy motorized actuators cannot be placed onto the scanner without drastically decreasing the scanner resonance frequencies, and hence limiting imaging performance.

Here, we present a novel tip-scanning AFM architecture allowing for placing the light source and photodetector, along with the adjustment opto-mechanics, completely off the scanner.[1] Only a set of passive optical guiding mirrors, whose mass is ~1% of the total scanned mass, are placed onto the scanner. This approach enables the optimization of the scanning mechanics separate from the adjustment mechanics, resulting in a low-scanned-mass, stiff planar flexure scanner design coupled without compromising on a robust, fully-motorized adjustment. Such a design is also compatible with adding a 2nd light source for photothermal cantilever excitation.

In addition to describing the principles of our approach, we demonstrate the performance of our system through a variety of imaging applications.

[1] Adams, J.D. U.S. Patent 10,564,181B2 (2020)