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# Development of a 3D-Printed Force Sensor with Carbon Paste

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## Abstract

Force sensors play an important role in the biomedical devices industry, especially in motion- and pressure-related devices. Such sensors are designed to collect force or pressure data by converting it into electrical signals. The data can then be sent to and analyzed by a local or cloud-based processing unit. It is vital that the sensors can be fabricated in a way that time efficiency, cost efficiency, and quality are all maximized. The advent of three-dimensional (3D) printing has greatly facilitated prototyping and customized manufacturing, as compared to older crafting methods (such as welding and woodworking), 3D printing requires less skill and involves less costly materials making it much more time- and cost-efficient. Technological advancements have also improved the quality of the actual sensing materials used in sensor-based devices, and notably, carbon-based materials have become increasingly favored for use as sensing elements. In the presented sensor, the modern sensor fabrication methods of 3D printing and using carbon materials as sensing elements are combined.

The sensor presented as a proof of the above concepts is a cantilever flex sensor. The sensor consists of a 30 mm-long cantilever extending from a 2.5 mm-thick wall, with a second wall of the same thickness parallel to the cantilever. After designing this structure and printing it using a 3D printer, the top surface of the cantilever was coated with a thin layer of conductive carbon paste and two copper wires were stripped and soldered to a pair of copper alligator clips, to be used for testing purposes. To test the sensor, the two copper wires were clipped onto the sensor (Figure 1A) and each wire was connected to a multimeter probe on the end opposite of the alligator clip. Then, using a set of four through holes in the parallel wall (along with a slotted rod), the tip of the cantilever was pressed down to an angle of 5, 10, 15, or 20 degrees (Figures 1B, 1C, 1D, and 1E, respectively) below the original plane of the cantilever and held there for 2 minutes. The resistance between the ends of the cantilever was measured throughout each trial by the multimeter, and the results (Figure 1F) for each angle were compiled and analyzed to determine the effect of each depression angle on impedance change, and thus, the overall effectiveness of the sensor. In the future, a notable improvement would be miniaturizing the sensor to facilitate in integration of the sensor in wearable and biomedical devices.

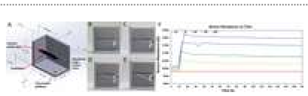

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**Figure 1**