HSLU Hochschule Luzern

Technik & Architektur
Master Thesis Elektrotechnik

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Laser Based Flexprint Manufacturing

Additive manufactured flexprints based on laser induced graphite and electroplated copper

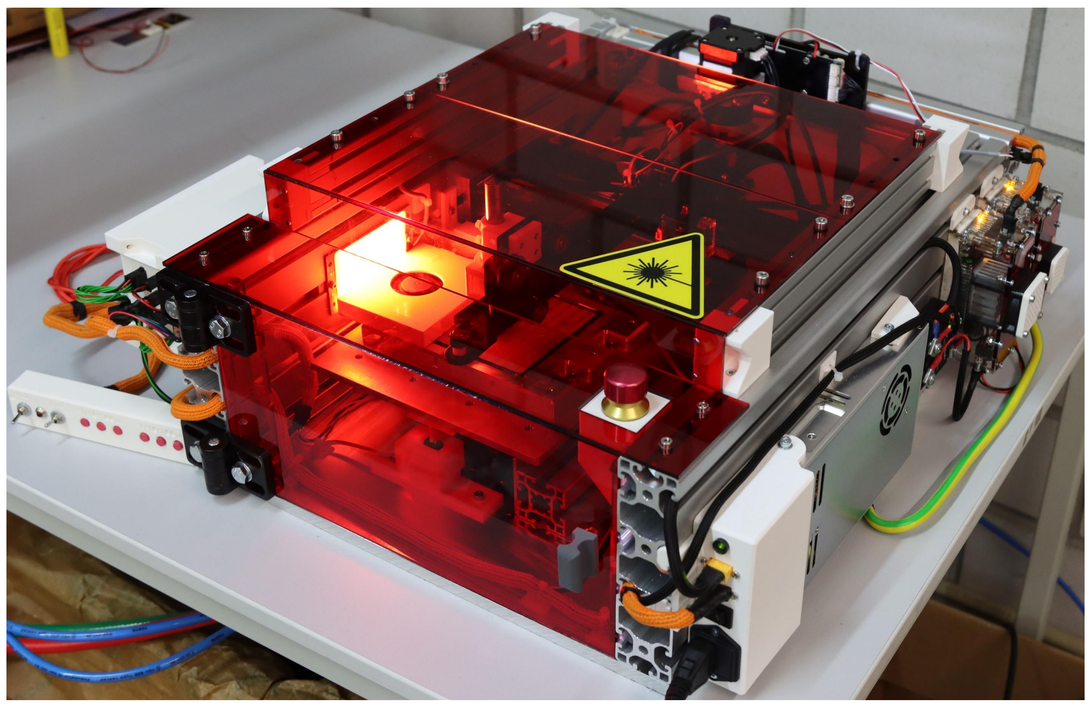

Figure 1: Laser setup

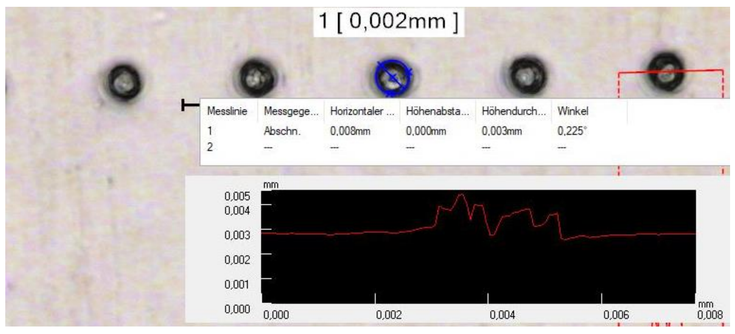

Figure 2: Minimal achieved feature size

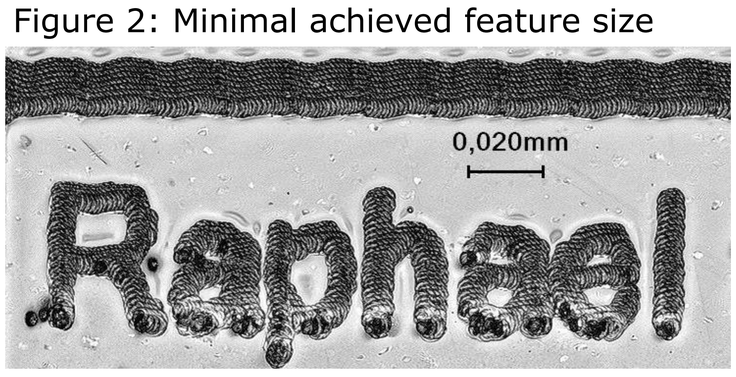

Figure 3: Two micrometer feature test

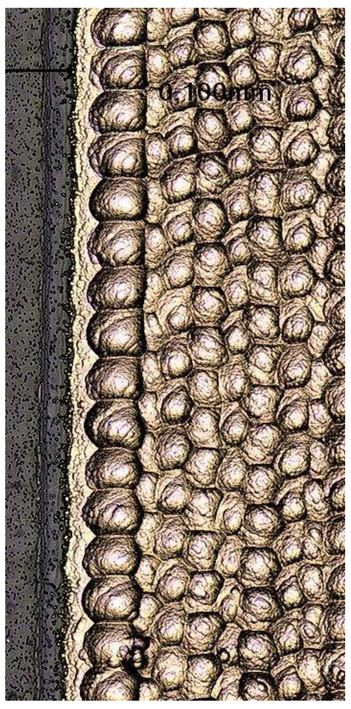

Figure 4: Electroplated surface

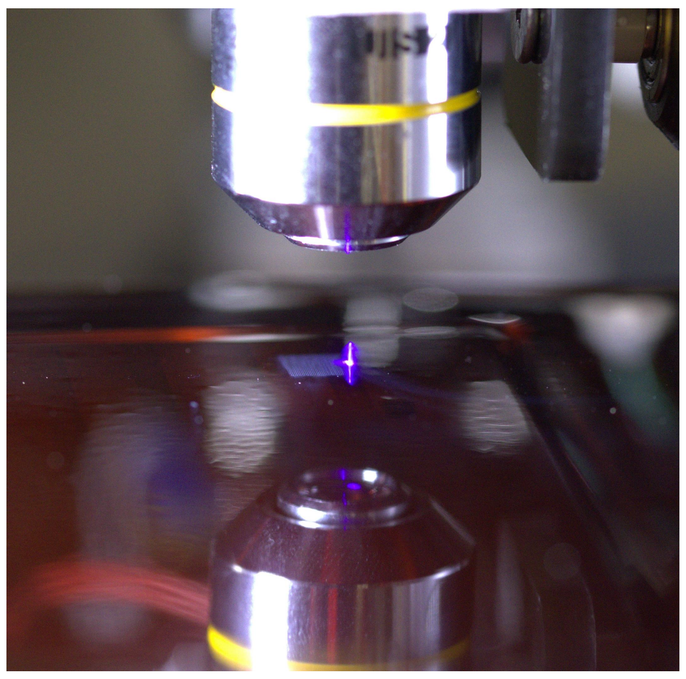

Figure 5: Laser induced carbonisation

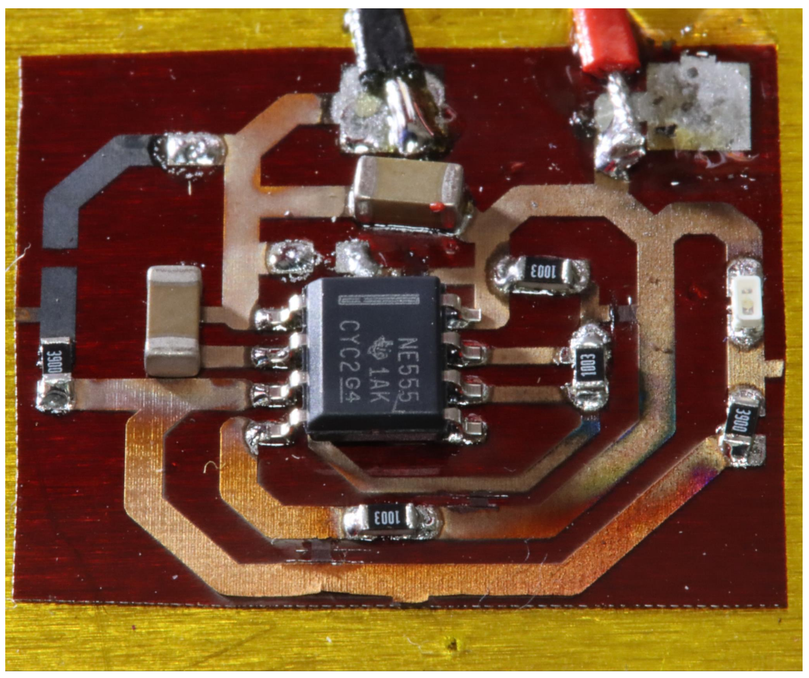

Figure 6: Working electronic prototype

Figure 7: Solder joint of electroplated graphite

Flexprint Manufacturing

The goal of this thesis is to find new approaches to produce flexprints with low feature size at low economic and ecological cost. Given the current emergence of disposable electronics for healthcare and other industries as well as supply chain issues, such a production method could improve ecological impact and production safety. The proposed process aims to decrease the feature size of flexprints, enabling the use of smaller ball grid array packaging and increasing components per wafer. Additionally, on-substrate manufacturing of passives will reduce the need for external components, thereby lowering costs and ecological impact. Due to being a maskless fully digital process, on-demand manufacturing can be achieved with high process flexibility. This project was self-submitted and financed.

Laser Induced Carbonisation

With laser induced carbonisation, a conductive base layer is generated on the polyimide substrate. For this, a new laser setup was built, to achieve a reduced feature size.

A 405 nm mono-mode laser diode was used, first collimated via triplet lens, and refocused with 10x microscope lens. To adjust the focal point, a height adjustable vacuum chuck was built to hold the flexible Polyimide substrate. As the carbon base laser does not have the conductivity needed for electronic traces, an additional copper layer was deposited via electroplating. After plating, components can be solder onto the copper layer. This manufacturing process also allows for manufacturing of carbon-based sensors and passive component directly on the substrate.

Results

With the new laser setup shown in Figure 1 laser induced carbonisation with a minimum feature size of 2 microns is achieved. The measured dot size and ability to form patterns via scanning is shown in Figure 2 and 3. Microscopic images of successful copper deposition via electroplating is shown in Figure 4. The ongoing laser process of carbonisation is shown in Figure 5.

Soldered resistors are shown in Figure 7, a low connection resistance of 2 Ohm including the traces was achieved. All this concludes in Figure 6, a working NE555 multivibrator demonstrator circuit. It’s a simple LED blink light but uses the developed fabrication process for its flexprint.

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