Metal Micromachining at Arizona State University's School of Earth and Space Exploration THz Laboratory

The SESE THz Laboratory is a new laboratory at Arizona State University with extensive experience in metal micromachining for terahertz waveguide applications. The leader of this lab, Prof. Christopher Groppi, has designed, fabricated and tested splitblock waveguide structures and quasi-optical components in brass, aluminum and tellurium copper for frequencies ranging from 100 GHz to 2.7 THz, for both his own research and outside customers. An example of a waveguide circuit made in tellurium copper for the 660 GHz waveguide band is shown in figure 1. Waveguide circuits have been provided for the National Radio Astronomy Observatory, the Space Research Organization of the Netherlands, Chalmers Institute of Technology, the University of Cologne, the NASA Jet Propulsion Laboratory and others.

Figure 1: A 660 GHz sideband separating mixer fabricated by Dr. Groppi for the Space Research Organization of the Netherlands. Critical dimensions are controlled to +/- 2.5um

Figure 2: The Kern Model 44 micromilling system used in ASU's SESE THz laboratory.

The SESE THz Laboratory is equipped with a Kern Model 44 micromilling system, shown in figure 2. This state of the art machine is capable of +/- 1µm positioning accuracy and repeatability, and can routinely produce on the part measured accuracy of +/- 2.5 µm. Feature aspect ratios of up to 10:1 are achievable. Specifications of this machine, and the parts produced with it are summarized in table 1.

All dimensions of critical features are measured using a precision metrology microscope equipped with high accuracy micrometers in the x,y and z axes. Metrology precision of +/- 2µm can be achieved with this system. Parts are delivered with a measurement report, where the measured dimensions of all critical features will be summarized. All critical dimensions can be held to +/- 2.5µm, modulo measurement errors of +/- 2µm. Measured surface roughness of Ra~0.075µm is typical. An example of a previously machined waveguide with this finish is shown in figure 3.

The SESE THz Lab is staffed with a machinist capable of making a wide variety of structures. He is supervised by Dr. Christopher Groppi, who has extensive experience designing and fabricating terahertz waveguide structures using these techniques.

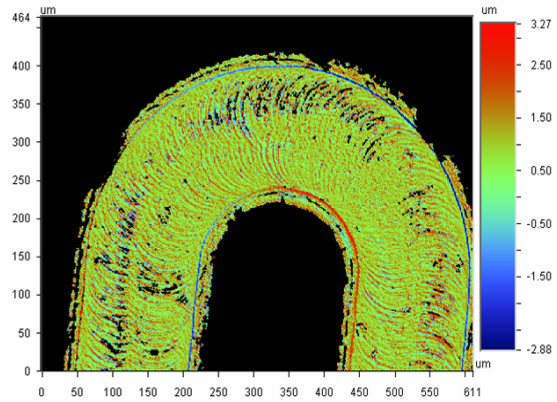

Figure 3: Veeco white light interferometric image of a waveguide floor produced by Dr. Groppi. The measured R_a is 0.075µm.

Specification	Value
On the part accuracy	+/- 2.5µm
Measurement accuracy	+/- 2.0µm
Surface Finish (Ra)	<0.1µm
Minimum feature size (xy)	10µm
Minimum feature depth	5µm
Maximum feature aspect ratio	10:1
Split block alignment	+/-2.5µm
Minimum radius of curvature	10µm
Maximum part size	300mm x 280mm x250mm

Table 1: SESE THz Lab Machining capabilities specifications