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Using Acrylic for Qualitatively Observing Laser Beam Characteristics

Using an acrylic swatch, or block can be a fast and cost effective method for obtaining a qualitative understanding of a CO2 laser's beam quality. Basically, a clear acrylic swatch is placed in front of the raw laser beam and the laser is turned on for a short period of time. The result is a three-dimensional feature depressed (ablated) into the acrylic that represents the wave-front – it's conical if the wavefront is gaussian.

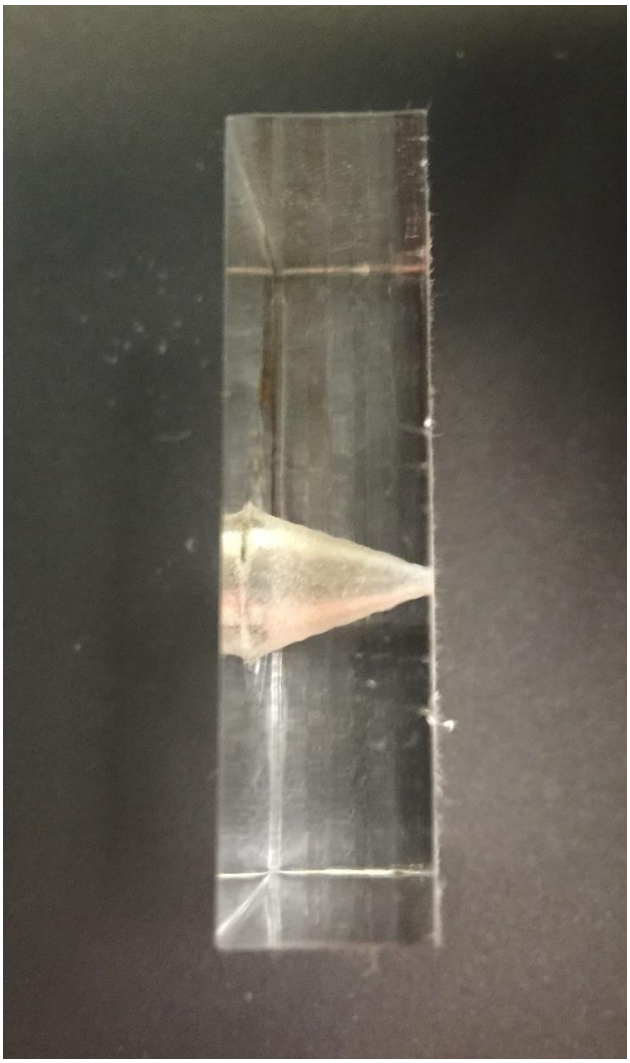

Figure 1 - Lateral View of a Wavefront Depression in Acrylic

Care must be taken when performing this test so that thermal heating of the area that surrounds the primary depression does not occur, and misrepresent the result. The casual tester may choose to simply run the laser CW at a particular duty cycle to generate the depression in the acrylic. This method will give some qualitative information about the beam quality, however it will most likely cause a flame and/or overheating of the acrylic surrounding the primary depression. This is typically seen as small bubbles and/or charring. If there is any overheating of the acrylic surrounding the primary depression, it will pre-melt, or soften these areas. These overheated areas are typically where the second-order modes, especially of unstable laser designs, are typically found.

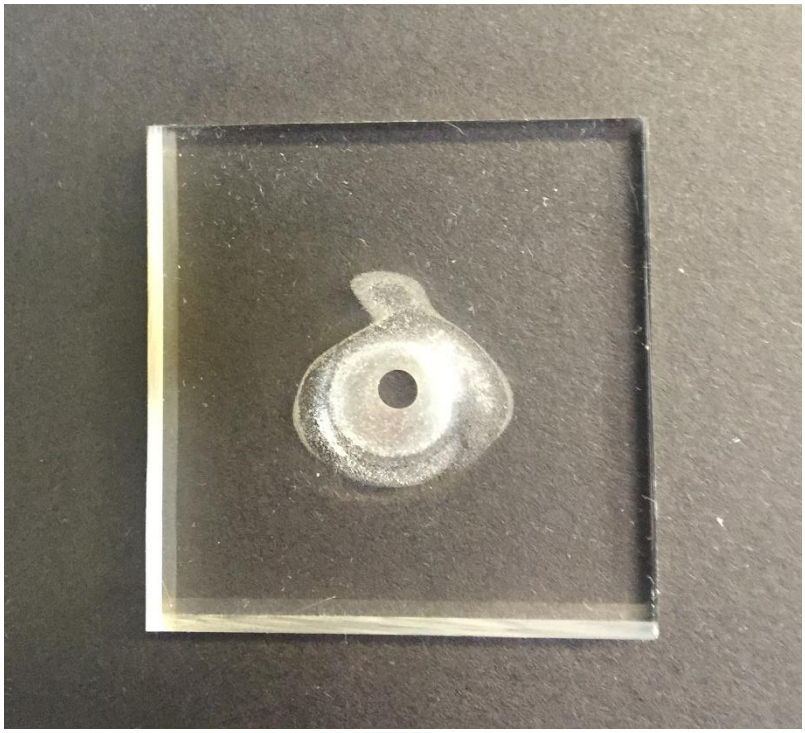

Figure 2 - Axial View of a Laser Beam Depression in Acrylic with the Laser Operating CW and Showing Premelted Acrylic, and Exaggerated Side Modes

To not overexaggerate second order modes by overheating and obtain a true unbiased representation of the beam quality, the preferred method is to fire the laser in short bursts that allow the acrylic immediately surrounding the primary depression to remain at a more consistent temperature and durometer, cooling between bursts. Threrefore, we suggest the following parameters as a protocol:

Laser Power (PWM):	100%
Laser Modulation Frequency:	1Khz
Laser On Time:	400ms, Burst
Distance to Acrylic	~1 Meter

At a rate no faster than 2-seconds, fire the 400ms Burst at the Acrylic swatch. Inspecting after each button firing, continue to fire the laser until the tip of conicle burn is touching, or has just penetrated the far wall of the Acrylic block and stop immediately.

Using this protocol the primary beam and side modes will be equally weighted. The result will be a more accurate representation of the laser beam's true wavefront and not exaggerate the side modes typical of unstable laser resonator designs.

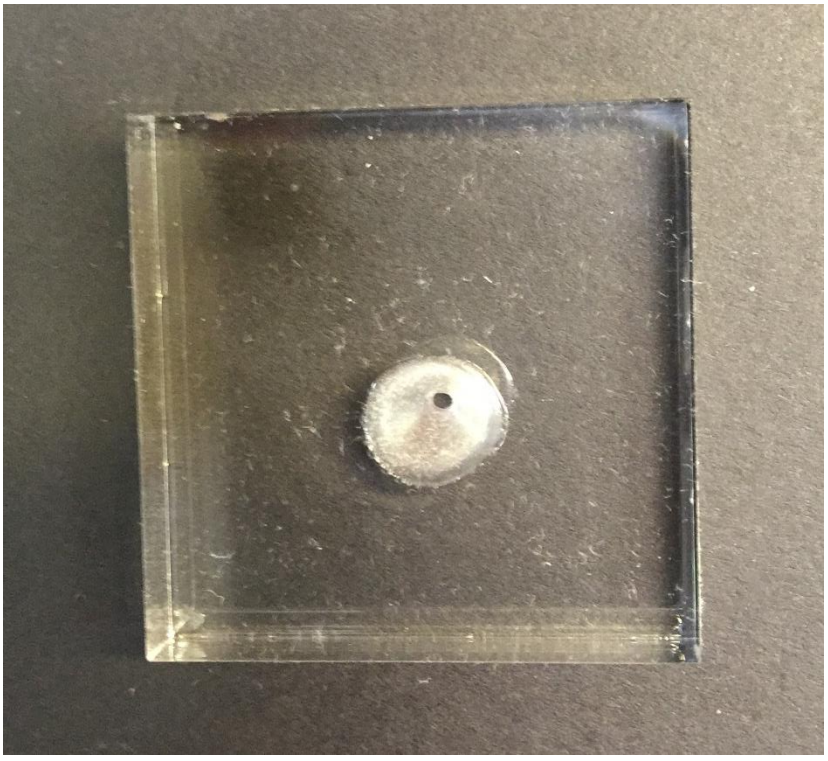

Figure 3 -Axial View of a Laser Beam Depression in Acrylic. Laser Operating Burst, Giving an Accurate Representation of the Laser Beam's Quality