Aspherical THz F-theta Lenses

Radiation control is necessary in many areas of terahertz photonics. This is mainly done using parabolic mirrors and spherical lenses. However the latter can be replaced with f-theta lenses to focus radiation in terahertz imaging and scanning systems as f-theta lenses provide a flat focal surface and an almost constant spot size over the entire scanning field.

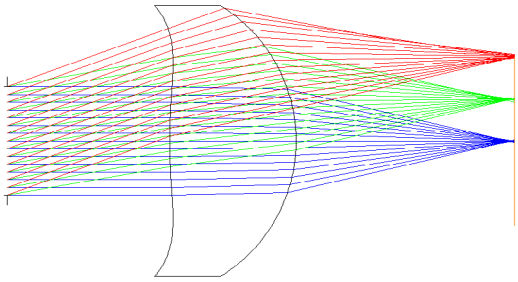

Fig. 1. THz aspherical f-theta lens

Such lenses are designed to provide a linear beam displacement of the beam dependence on the deflection angle, resulting in a constant scanning speed on a flat surface. F-theta lenses also provide a constant broadband THz phase in the scanning plane and high image resolution. The images formed by f-theta lenses have barrel distortion, and the position of the spot on the image plane is directly proportional to the scanning angle. This feature eliminates the need for complex electronic setup and allows a fast, relatively inexpensive and compact scanning system to be assembled.

Here are parameters of an aspherical f-theta lens example.

Material	COC TOPAS (Cyclic Olefin Co-polymer TOPAS)
Diameter, mm	100
Thickness, mm	40.3
Operating wavelength range, μm	300-3000
Focal length, mm	90

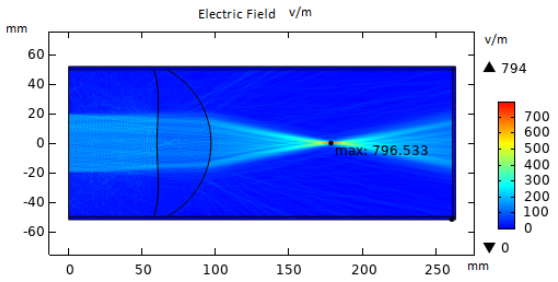

Fig. 2. Spatial distribution of electric field strength of a THz beam focused by an f-theta lens

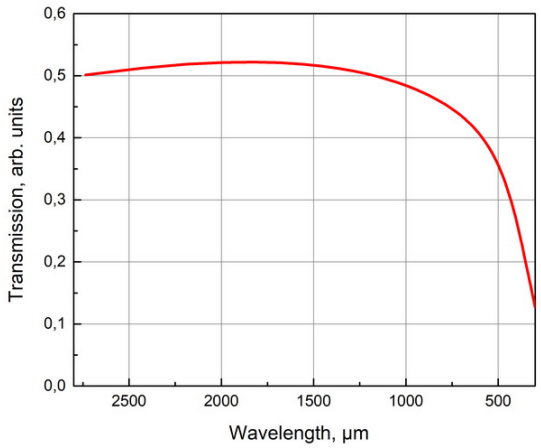

Fig. 3. Transmission spectrum of a 40 mm thick f-theta lens along the axis

Fig. 4 shows the dependence of the transverse coordinate of the THz radiation maximum at the focus of the lens on the deflection angle (the angle of incidence of THz beam on the f-theta lens). As it can be seen from this figure, in the range of angles from -25 to +25 degrees this dependence is linear, which allows constant speed scanning of a flat surface.

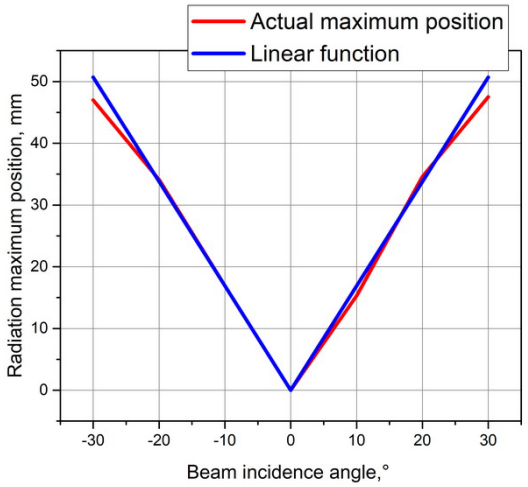

Fig. 4. Linearity of the f-theta lens characteristics

THz aspherical f-theta lenses are manufactured to customer specifications. To perform the calculation it is necessary to specify diameter, wavelength, focal length, scanning angle, scanning field and input beam dimensions.

Valid parameters:

Material	COC TOPAS (Cyclic Olefin Co-polymer TOPAS)
Diameter, mm	25.4 to 200
Thickness, mm	Up to 200
Operating wavelength range, μm	300-3000
Focal length, mm	≤ 200

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