

Comparison using FEA between cylindrical, spherical, and conical configurations of optical choppers with shafts

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Abstract: Optomechanical choppers are commonly built as rotational disks, but this configuration is limited in terms of the frequency of the laser impulses they produce. This chop frequency is limited to maximum 10 kHz for macroscopic choppers, but in reality it does not exceed 3 kHz because of vibration issues. While Micro-Electro-Mechanical Systems (MEMS) are a solution to this drawback, we have adopted another, lower cost strategy and introduced (patent pending) a novel type of macroscopic device: choppers with rotational shafts. The aim of this paper is to present our final study, using Finite Element Analysis (FEA), regarding the three possible shapes of shafts we have introduced: cylindrical, spherical, and conical. For each shape of shafts, a range of characteristic parameters is considered: shaft diameter, number and width of the slits, and rotational speeds of the shafts — the latter of up to 120 krpm. Both the structural integrity and the deformations of the shafts are compared, for the three shapes, and the specific differences are calculated. The most appropriate material, an Al alloy is considered, for all devices, as from our studies it behaves better than steel for such applications, while it has lower costs than beryllium (which is also toxic during manufacturing). From the multi-parameter analysis carried out, conclusions are drawn on the optimal configuration and parameters of such optical choppers with shafts.

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