Inverted Dielectric Rod Feed for Reflector Antennas

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The dielectric rod (DR) antenna has proven effective in dual and tri band antenna feeds where it can be used to support one or two bands while being effectively isolated from a third band [1]. The conventional DR taper antenna has a number of electromagnetic and mechanical constraints that limit its more general applicability as a parabolic antenna feed. The gain depends on length but the maximum gain is relatively low (typically <15dB), the phase centre of the antenna is quite frequency dependent, the gain is not always a maximum on axis, the power handling is low and there are limited options for controlling the feed pattern [2]. In mechanical terms the structure is fragile, difficult to machine accurately, thermal conductivity is low, and precision alignment difficulties and vibration sensitivity further complicate the performance. Virtually all of these electromagnetic and mechanical issues can be resolved simply by changing to the "inverted" DR taper, which is shown in Figure 1. This paper shows that the inverted DR antenna is considerably superior to the conventional DR antenna, and that the inverted DR feed is a realistic alternative to the conventional corrugated horn and is eminently suitable for a combined RF/Optical feed.

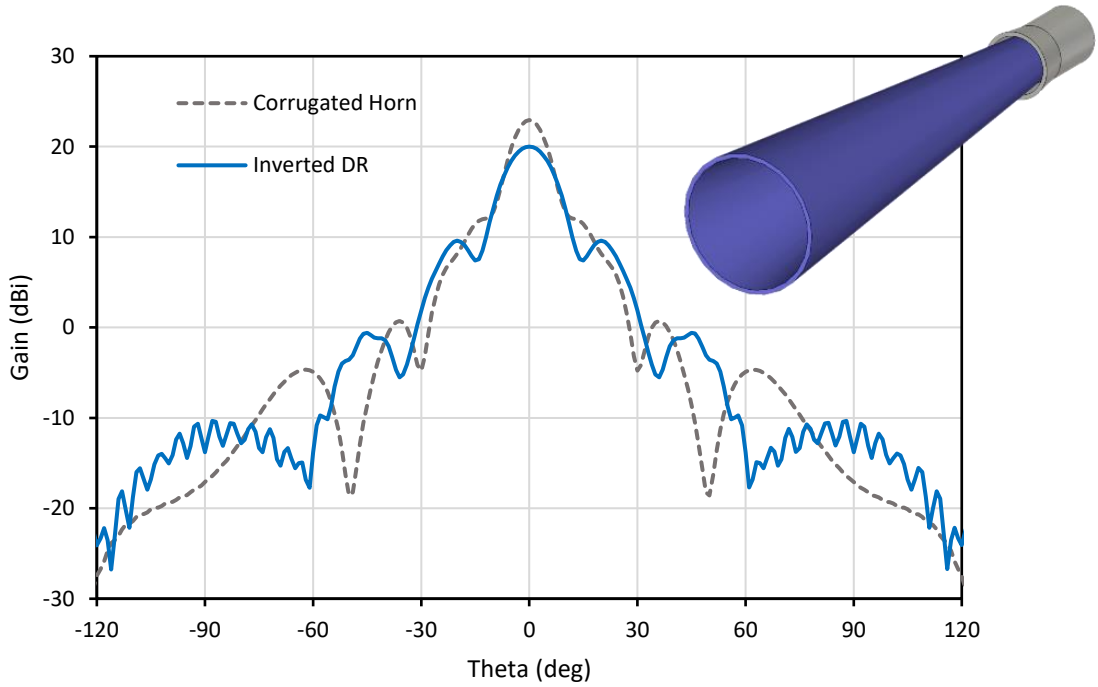

Fig. 1: Plot of simulated RHCP 30GHz radiation patterns of an inverted DR antenna (depicted top right), and a corrugated horn. Both are ~12λ in length and optimised for gain over the Ka band.

The design emphasis was on the Ka(~18-32GHz) band, but the results are scalable. Simulated results show that variation of the basic design parameters offers flexible control of radiation patterns and frequency characteristics. Antenna gain is a complex function of taper angle, and 21dB is readily achieved using a physically realisable Rexolite construction. By selecting various tapers, it is possible to design an inverted feed that has approximately flat gain with frequency over a wide bandwidth, or one for which gain increases approximately as 10logF. Likewise, antenna length, taper, and terminating width can be used to control radiation patterns.

[1] Zhang, Pengyu & Qi, Jiaran & Qiu, Jinghui. (2017). Efficient design of axially corrugated coaxial-type multi-band horns for reflector antennas. International Journal of Microwave and Wireless Technologies. 9. 1-7. 10.1017/S175907871700085X.

[2] Saffold, Gabriel, "Theory and Application of Dielectric Rod Antennas and Arrays" (2021). USF Tampa Graduate Theses and Dissertations.