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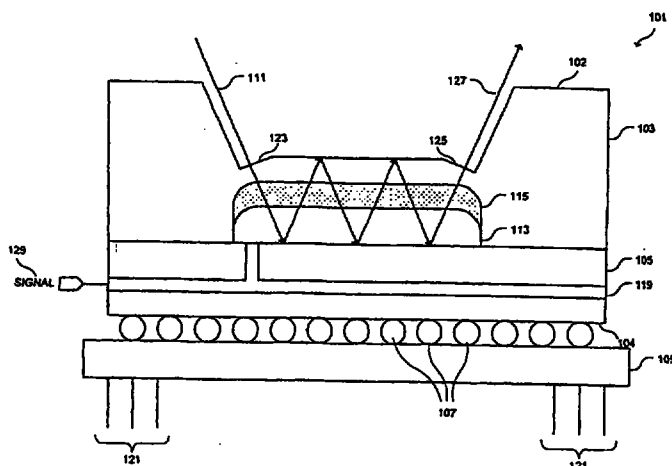
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- (71) Applicant (for all designated States except US): **INTEL CORPORATION [US/US]; 2200 Mission College Boulevard, Santa Clara, CA 95052 (US).**
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **KOEHL, Sean, M. [US/US]; 383 Sara Avenue, Sunnyvale, CA 94086 (US). PANICCIA, Mario, J. [US/US]; 4662 Wilcox Avenue, Santa Clara, CA 95054 (US). NIKONOV, Dmitri [RU/US]; Apartment #901, 2200 Monroe Street, Santa Clara, CA 95050 (US).**
- (74) Agents: **MALLIE, Michael, J. et al.; Blakely, Sokoloff, Taylor & Zafman LLP, 7th floor, 12400 Wilshire Boulevard, Los Angeles, CA 90025 (US).**
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(54) Title: **METHOD AND APPARATUS FOR OPTICALLY MODULATING AN OPTICAL BEAM WITH A MULTI-PASS WAVE-GUIDED OPTICAL MODULATOR**



(57) Abstract: An optical modulator (101) that modulates light through the semiconductor substrate (103) through the back side of an integrated circuit die (103). In one embodiment, an optical modulator is disposed within a flip chip packaged integrated circuit die (103). The optical modulator includes a modulation region (115) through which an optical beam is passed a plurality of times. In one embodiment, the optical beam (111) enters through the back side of the semiconductor substrate at a first location (123) and the modulated optical beam (127) is deflected out through a second location (125) on the back side of the semiconductor substrate (103). The interaction length of the optical modulator is increased by internally deflecting and passing the optical beam through the modulation region a plurality of times. In one embodiment, total internal reflection is used to deflect the optical beam. In another embodiment, reflective materials (233) are used to internally deflect the optical beam. In one embodiment, the modulation region is provided with a charged region formed with a p-n junction (115, 215). In another embodiment, the charged region is provided using metal-oxide-semiconductor type structures (315, 415).



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