Electrostatic Micromirrors for Retro-Reflective Optical Communication

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***Abstract*— Optical communication has rapidly emerged as an alternative to wireless radio communication, especially in situations where stealth and radio silence is paramount. Such situations exist in critical military operations, where blinking Morse code lights have evolved into more sophisticated forms of digital communication. Certain types of multi-node sensor networks also benefit from optical communication, especially in systems where a central, non-battery powered control node interrogates many remote, battery powered sensors. Through pioneering work in optical micro-electrical mechanical systems (MEMS) devices, our research team has created a system that can effect multiple concurrent digital communication operations using a dc laser beam and a two-state, electrostatically actuated MEMS retro-reflective mirror. The device maximizes returned light intensity when the MEMS mirror is planar, and minimizes it when the MEMS mirror is deformed. As a result, the intensity of the returned beam can be modulated by up to 90%. Two way communication between optical nodes can be realized through a variety of time based communication protocols, including analog or digital FM, digital AM, and pulse-width modulation. Of note is a new method for fabricating the mirrors based on silicon-nitrate electrets. Such devices result in a mirror surface is deformed with no electrostatic actuation, and planar only after voltage is applied. Systems based on electret biased mirrors drastically reduce power drain in battery-powered applications.**