Abstract
A tactile display provides information to a user by stimulating their sense of touch. This information could be presented using characters, symbols, signals or physical forces (e.g. pressure and electrical stimulation). In the field of tactile technology, research has been conducted into devices for disabled people and medical instruments of teletaction for teleoperation (i.e. remote surgery). Refreshable Braille displays contain tactile devices for the blind and partially sighted, translating text from a computer into readable characters. A Braille display consists of a number of Braille cells, with each containing either six or eight dots arrayed in two columns. Conventional refreshable Braille cells employ metal pins that are independently raised. Today, demand for refreshable Braille displays is increasing, among those within the blind and partially sighted community that wishes to access modern information systems.

A new concept for the realization of a refreshable Braille cell is presented. An electrothermally controlled microactuator that exploits the hydraulic pressure due to the volumetric expansion of melted paraffin wax is described. The paraffin wax is contained within a bulk micromachined silicon container. The container is sealed using an elastic diaphragm of silicone rubber. The container is heated using gold microheaters located on an underlying glass substrate. All the layers used to make up the containers are bonded together using an overglaze paste. The complete 3 × 2 dot Braille cell has air gaps between containers, to prevent unwanted actuation by means of heat leakage from adjacent containers. The prototype Braille cell measures 7 × 8.5 × 2 mm$^3$ and its raised dots are held in equilibrium by pulsed actuation voltages. In order to maintain a dot height at 50 % of its maximum, a duty factor of more than 0.8 was found. The total actuation time for a dot on an up/down cycle was ~ 50 seconds. The dot height increases with an increasing duty factor with a fixed PRF, and increases with decreasing PRF with a fixed duty factor. A stable maximum dot height was achieved by reducing the cooling time.

Fig. 1. (a) Proposed concept using an electrothermal actuator for a six dot cell and (b) Micromachined Braille cell design (exploded view)

Fig. 2. (a) SEM of the underside view of the assembled paraffin wax container bonded using overglaze, (b) actuation of the Braille dot after 1 minute