Medicine Delivery Device With Integrated Sterilization and Detection

This automated medicine delivery device would ensure that patients receive medication on schedule and at the right dosage level.

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Sterile delivery devices can be created by integrating a medicine delivery instrument with surfaces that are coated with germicidal and anti-fouling material. This requires that a large-surface-area template be developed within a constrained volume to ensure good contact between the delivered medicine and the germicidal material. Both of these can be integrated using JPL-developed silicon nanotip or cryo-etch black silicon technologies with atomic layer deposition (ALD) coating of specific germicidal layers.

The application of semiconductor processing techniques and technologies to the problems of fluid manipulation and delivery has enabled the integration of chemical, electrical, and mechanical manipulation of samples all within a single microfluidic device. This approach has been successfully applied at JPL to the automated processing, detection, and analysis of minute quantities (parts per trillion level) of biomaterials to develop instruments for *in situ* exploration or extraterrestrial bodies. The same nanofabrication techniques that are used to produce a microfluidics device are also capable of synthesizing extremely high-surface-area templates in precise locations, and coating those surfaces with conformal films to manipulate their surface properties. This methodology has been successfully applied at JPL to produce patterned and coated silicon nanotips (also known as black silicon) to manipulate the hydrophilicity of surfaces to direct the spreading of fluids in microdevices. JPL's ALD technique is an ideal method to produce the highly conformal coatings required for this type of application.

Certain materials, such as TiO_2, have germicidal and anti-fouling properties when they are illuminated with UV light. The proposed delivery device contacts medicine with this high-surface-area black silicon surface coated with a thin-film germicidal deposited conformally with ALD. The coating can also be illuminated with ultraviolet light for the purpose of sterilization or identification of the medicine itself. This constrained volume that is located immediately prior to delivery into a patient, ensures that the medicine delivery device is inherently sterile.

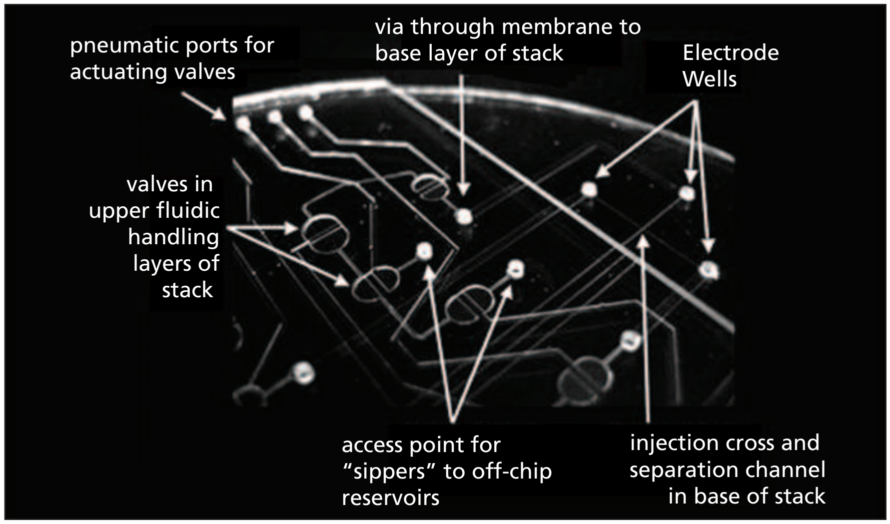

Figure 1. **JPL's Microfluidic Chip** for sample preparation, delivery, and analysis.

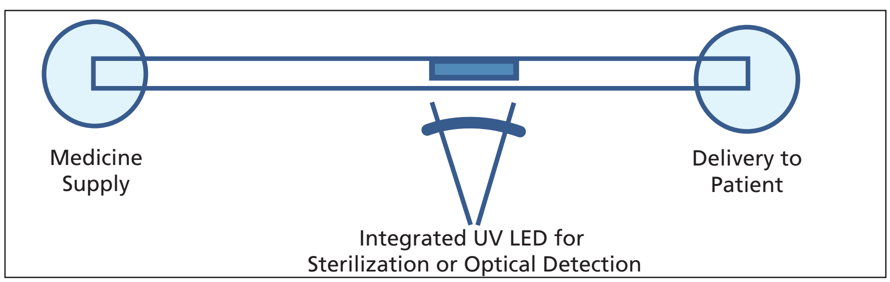

Figure 2. Schematic of a **Microchannel** in the medicine delivery device with integrated sterilization or analysis on an extremely high-surface-area template.

An additional benefit to integrating a high-surface-area template within the fluid channel of a medicine delivery device is that one can envision a number of different functional coatings that could facilitate the capture and analysis of either microbial contaminants or the medicine itself. For example, one could attach antibodies or some other binding agent with a specific affinity to the silicon nanotip template. Once a target molecule or microbe is bound to the high-surface-area template, one could use an optical analytical technique such as fluorescence or adsorption to determine the identity and potentially the concentration of the species of interest. By illuminating the bound species from the back, it may also be possible to probe only the molecules with an evanescent wave, making detection of the species from the front side of the device much simpler.

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