Fabrication of superhydrophobic and superhydrophilic surfaces for biomicrofluidics applications

The exciting functionalities of naturally superhydrophobic and superhydrophilic surfaces, e.g. the extreme water repellency of the lotus flower, has served as inspiration for a variety of biomimetic designs. In recent years it has been successfully demonstrated that both hydrophobic and hydrophilic surfaces can be fabricated by femtosecond laser machining. Figure 1 compares the SEM images of a rose petal surface and a superhydrophobic surface machined on polypropylene using Spirit® One™ femtosecond laser from Spectra-Physics®. The imitation of the surface morphology leads to one-to-one reproduction of the wetting properties of rose petals. In particular, it was possible to fabricate superhydrophobic polypropylene surfaces which exhibits non-sticky behavior.

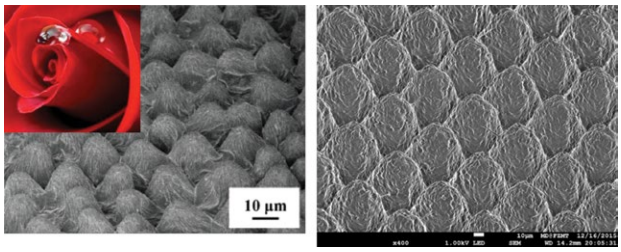

Figure 1. SEM images of rose petal surface (left) and superhydrophobic surface on polypropylene machined using fs Spirit® One™ laser from Spectra-Physics (right). *Image source: Feng et al., Langmuir 24(8), 4114–4119 (2008).*

In contrast to extensively studied techniques for fabrication of superhydrophobic surfaces, little attention has been paid to combining both extreme wetting states to micropatterns. However, such micropatterns offer exciting possibilities for the design of biomedical and microfluidic devices. Recently, a femtosecond laser based process, ClearSurface™, for fabrication of functional surfaces has been developed at the research center for micro-technology at the Applied University in Dornbirn, Austria in collaboration with Spectra-Physics. The patent-pending ClearSurface process in combination with the Spirit One industrial femtosecond laser (Figure 2) allows the fast and flexible fabrication of superhydrophilic micropatterns (contact angle < 5°) on a superhydrophobic background (contact angle > 150°). The innovative process enables the application of these wetting properties to variety of substrates and the resulting contact angle can be precisely controlled by adjusting the laser parameters.

Figure 2. Spectra-Physics' Spirit® One™ high performance industrial femtosecond laser.

Figure 3 shows an example of surface-tension based microchannels and reservoirs created using a Spirit One laser, which can be wetted simply by dipping the sample into the liquid. Due to the high wettability gradient of the surface the liquid only spreads on the predefined superhydrophilic microchannels and reservoirs. This surface-tension based self-patterning effect is attractive for a wide range of applications, especially in the field of biomicrofluidics, where micropatterns can be used for cell culturing, screening purposes, and to generate centimeters-long gradients of molecules and particles. Because of the high flexibility of the ClearSurface process, even complex micropatterns can be generated easily.

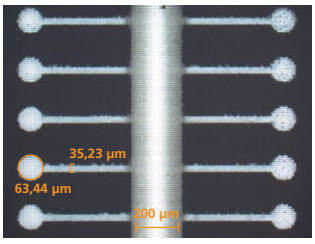

Figure 3: Wetted superhydrophilic microchannels and reservoirs (light grey areas), image taken by optical microscopy

Spectra-Physics®
A Newport Company

Fabrication of superhydrophobic and superhydrophilic surfaces for biomicrofluidics applications

PRODUCTS: *SPIRIT ONE*

Spirit® One™ is a compact, industrial femtosecond laser that delivers game-changing cost-performance with averages powers up to >8 W. With ultrashort <400 fs pulse width, high pulse energy and average power output, and repetition rate up to 1 MHz, the laser is an It's in the Box™ laser that combines power supply and laser head in a single rugged, compact and lightweight package for ease of integration. Spirit One provides additional flexibility with a new adjustable pulse duration option, allowing the user to freely choose pulse durations between <400 fs and 4 ps by software in less than 3 seconds. Spirit One enables advancements in high precision applications including microsurgery, femtosecond micromachining, medical device manufacturing, optogenetics, and multiphoton microscopy.

	Spirit One 1040-8
Wavelength	1040 nm ±5 nm
Output Power[2] at 1040 nm	>8 W
Pulse Energy at 1040 nm	>40 µJ at 200 kHz
Pulse Width	<400 fs

Spectra-Physics®
A Newport Company

www.spectra-physics.com

3635 Peterson Way, Santa Clara, CA 95054, USA
PHONE: 1-800-775-5273 1-408-980-4300 FAX: 1-408-980-6921 EMAIL: sales@spectra-physics.com

Belgium	+32-(0)0800-11 257	belgium@newport.com	Korea	+82-31-8069-2401	korea@spectra-physics.com
China	+86-10-6267-0065	info@spectra-physics.com.cn	Netherlands	+31-(0)30 6592111	netherlands@newport.com
France	+33-(0)1-60-91-68-68	france@newport.com	Singapore	+65-6664-0040	sales.sg@newport.com
Germany / Austria / Switzerland	+49-(0)6151-708-0	germany@newport.com	Taiwan	+886 -(0)2-2508-4977	sales@newport.com.tw
Japan	+81-3-3794-5511	spectra-physics@splasers.co.jp	United Kingdom	+44-1235-432-710	uk@newport.com

SP-AP-20160816