Ultra-thin-film Deposition Processes for Controlled Hydrophilicity and Hydrophobicity by Molecular Vapor Deposition

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Molecular Vapor Deposition (MVD®) replaces traditional liquid coating processes with a highly reproducible vapor deposition alternative that is ideal for manufacturing applications. The deposited thin films can be used as lubricative, protective, hydrophobic, hydrophilic, biocompatible, or reactive coatings. A precise control of wetting properties can be achieved on a variety of materials and over intricate features with high aspect ratios. Anti-stiction films are created by deposition of fluorocarbon materials and will benefit various MEMS devices including displays, sensors, actuators, RF switches, inkjets, and data storage devices. For biological MEMS, excellent wetting control can be achieved on micro-fluidics (lab-on-a-chip, microplates). MVD® is also used for commercial applications requiring moisture barriers, anti-corrosion coatings, or release layers for imprinting.

The MVD® technology was developed to deposit ultra-thin, functionalized, both organic and inorganic films with higher yields and better cost efficiencies than traditional liquid deposition techniques. Such films serve as lubricative, protective, hydrophobic, hydrophilic, biocompatible, or reactive coatings. We have described elsewhere examples of the unique properties obtained by MVD® coatings at CSEM *e.g.,* barrier layers for miniature atomic clocks [1], apolar monolayers for MEMS gas chromatograph [2], and ice-phobic coatings [3].

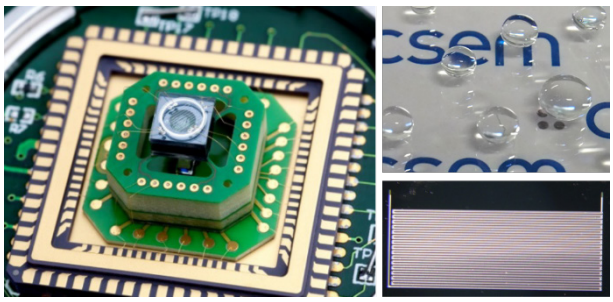

Figure 1: Applications of MVD® thin films at CSEM. Clockwise from left: Miniaturized atomic clock; Nanostructured, transparent and super-hydrophobic surfaces; apolar column structures for MEMS chromatograph.

Amongst other properties, MVD® coatings are particularly appropriate as means of controlling the wetting properties or functionality of the surfaces. Therefore, the surface energy of several type of chemistries deposited by the MVD® technology was characterized and results are shown in Figure 2.

Moreover, we have shown that the wetting properties of dense layers are mainly controlled by the molecular chemistry. Dependency of the density, thickness, and properties of the coatings on the depositing parameters was fully characterized and the coating processes were optimized for each application.

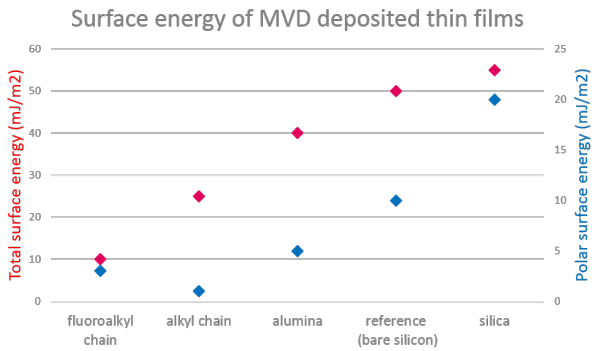

Figure 2: Total surface energy (red) and polar surface energy.

Biotech devices in the field of lab-on-a-chip MEMS and microfluidics rely heavily on the wetting properties and surface functionality of intricate shapes and channels. In collaboration with DBS System SA, producer of HemaXis™ devices, we developed unique hydrophilic coatings to improve blood collection in dried blood sampling system. The coatings are conformal on high aspect ratio structures such as plastic micro-channels and allow for easier and faster blood transport through the devices.

Figure 3: HemaXis™ blood collection sampler includes microchannels covered with a highly conformal hydrophilic MVD® coating.

Controlling the wetting properties of surfaces is critical for numerous applications such as biomedical systems, aeronautics, watchmaking, or MEMS devices. MVD® technology provides a method for reproducibly coating complex high-aspect-ratio structures in a wide range of materials in a manner which is highly compatible with industrial applications.

• DBS System SA, Gland, Switzerland

[1] T. Overstolz, *et al.*, "Improved Lifetime of Miniaturized Vapor Cells in Atomic Clocks", CSEM Scientific & Technical Report (2016), 34.

[2] A. Hoogerwerf, "Design of a MEMS Gas Chromatograph", CSEM Scientific & Technical Report (2015), 26.

[3] E. Scolan, *et al.*, "Icephobic Coating Associated with Low-power Electromechanical De-icers", CSEM Scientific & Technical Report (2015), 44.