

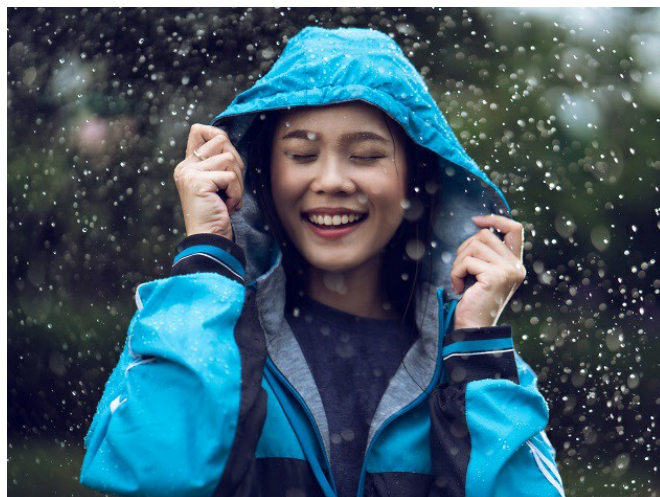
DATASHEET USING EVAPORATION TO CREATE HYDROPHOBIC COATING A078

APPLICATION NOTE

Using evaporation to create hydrophobic coating

with mass flow instruments

Empa, one of our European research customers, uses a Bronkhorst evaporation system named CEM (Controlled Evaporation & Mixing) in their quest to develop hydrophobic coatings for water-repellent fabric. Empa, a Swiss Federal Laboratory for Materials Science and Technology and a part of the ETH Domain, employs a CEM system comprising a liquid mass flow meter and a gas mass flow controller. This system actively evaporates silicon organic HMDSO. Empa uses plasma polymerisation to deposit thin (nanoscale) layers on top of fabrics and fibers. In this process flow controllers add the polymer precursors.



Application requirements

In the low-pressure (0.1 mbar) plasma polymerization process at Empa, the plasma actively evaporates and activates the liquid silicon-organic compound hexamethyldisiloxane (HMDSO - $C_6H_{18}OSi_2$). The primary objective is to polymerize and deposit the resulting vapor onto the surface of the fiber, creating a hydrophobic coating. To achieve a stable and consistent flow of the polymer precursor vapor, precise control is required for both the liquid HMDSO flow and the carrier gas flow. The HMDSO vapor is introduced into the plasma chamber at defined flow rates, where higher rates facilitate rapid deposition and processing.

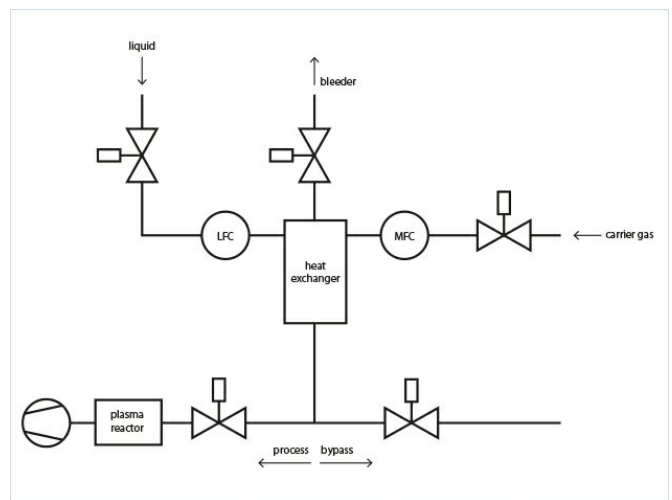
Important topics

- Accurately controlled gas/liquid mixture
 - Stable vapor flow
 - Low to high vapour flow rates
-

Process solution

The Bronkhorst CEM evaporation system evaporates silicon organic HMDSO (hexamethyldisiloxane). In this process, the system draws liquid HMDSO from a container at room temperature and measures it using a liquid mass flow meter (mini CORI-FLOW series). Next, it combines the liquid HMDSO with argon carrier gas from a thermal mass flow controller (EL-FLOW Select series) and vaporizes it within a heat exchanger for precise heating control. The heat-induced vapor flow is then introduced into the plasma reaction chamber, which operates at 0.1 mbar absolute pressure. The entire evaporation process is controlled by a PLC system.

By employing this configuration, HMDSO can be evaporated within a broad range of 1 to 30 grams per hour. The findings demonstrate the generation of vapor flows in a stable, precise, consistent, and effectively regulated manner.



Flow scheme showing CEM evaporation system

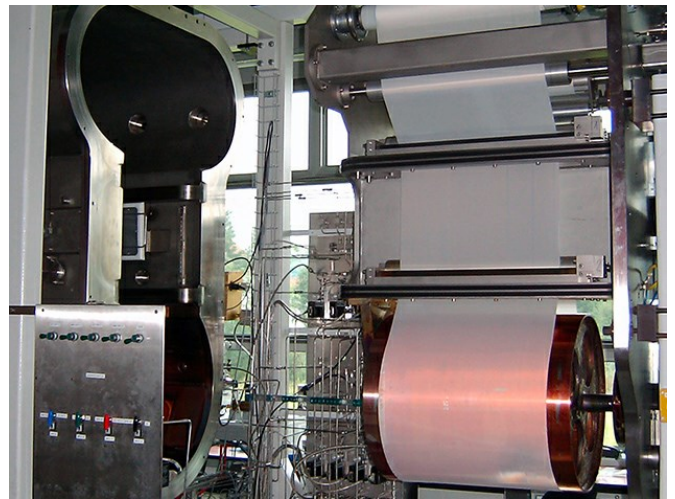
Software used in this evaporation process

The evaporation process in this setup utilizes LabVIEW software for simple and effective visualization. The traditional bubbler system, which had a limited low flow rate of carrier gas and precursor, has been replaced by the currently used CEM vapor system. This transition has brought several benefits.

Benefits gained using CEM evaporation system

With the CEM system, Empa achieves a higher gas yield of 50 ml/min compared to the previous bubbler system, which only allowed 4-5 ml/min of gas flow. Additionally, the flow of HMDSO liquid has been increased. Empa's goal is to scale up the process from the laboratory scale to an industrial scale.

The CEM system currently used at Empa is portable and compact. This mobile setup, resembling a small office table on wheels, enables easy movement between laboratories. The compactness of the Bronkhorst devices further enhances the flexibility of engineered flow solutions.



The HMDSO setup enables the deposition of polysiloxane coatings at low temperatures, making it suitable for coating textile fibers that cannot withstand high temperatures. Empa's efforts to conduct plasma polymerization at low pressure aim to increase production yield by facilitating heterogeneous deposition on the fiber's surface and reducing the amount of chemicals involved.

Recommended Products



EL-FLOW SELECT F-201CV

Min. flow 0,16...8
mln/min
Max. flow 0,5...25 lln/min
Pressure rating 64 bar
Compact design
High accuracy and
repeatability



MINI CORI-FLOW™ M12

Flow range 0...200 g/h
Pressure rating 200 bar
Independent of fluid
properties
High accuracy, fast
response



CEM EVAPORATOR W-102A

Max. 30 g/h liquid;
Max. 4 lln/min gas
Pressure rating 100 bar
Very stable vapor flow
Flexible gas/liquid ratio