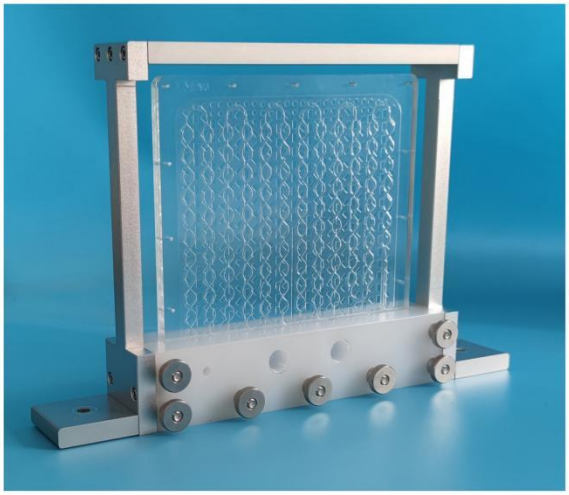
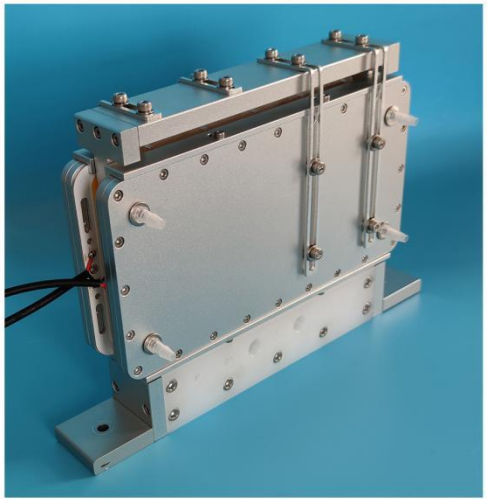
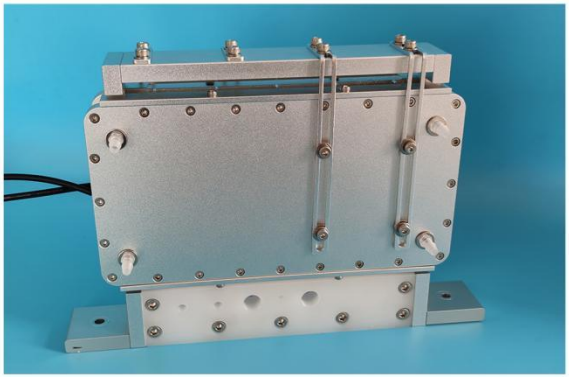
Microflu Microfluidics Technology (Changzhou) Co., Ltd.

Continuous Flow Systems


MF V6G&V9G Photochemical Reactors & Continuous Flow Photoreactors

A Photochemical reactor is a device that uses light (Photon) to perform a chemical reaction. Typically, the

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chemical reactions need a high temperature (about 100 to 250 degrees Celsius) for a large production scale. However, this process also gives useless byproducts and losses. With the help of a photoreactor, the process of material synthesis becomes easy. It is efficient and does not produce unwanted byproducts. Mainly this reaction carries out in the presence of photon and catalyst; hence it is called a Photocatalytic reactor. The process of photochlorination, water splitting, aflatoxin production, sulfonation, sulfoxidation, and nitrosylation can be performed successfully using this reactor setup. The reactor is also known as a UV reactor because the "light" we talk about here is commonly ultraviolet light. Comparing it to the traditional methods is much more reliable, consistent, and precise and gives opportunities to explore photochemistry.

Photochemical reactor is is mainly applied to research gas / liquid phases, fixed / simulated visible light, Photochemical reaction under conditions of photocatalyst,etc. Be widely used in fields of Chemosynthesis, environment protection, life science, etc.

Continuous flow photochemical reactors can improve the efficiency of chemical synthesis, and can also perform reactions that would otherwise be impossible.MICROFLU™ photochemistry reactor is modular, flexible, scalable and easy-to-use, it makes modern photochemistry techniques accessible without the limitations of traditional batch requirements.

The photochemical reactor system is appropriate for "free radical" reaction mechanism. Its application is highly popular in fields such as halogenations of organic compounds, production of primary mercaptans, oxidation, isomerizations, polymerizations, hydrogen generation, solar application, Photolysis of toxic wastes etc.

Photochemistry is also used in the curing (polymerization) of specially formulated printing inks and coatings. Used in research and science, environment, green/clean energy, water splitting and so on. Our products are distinct, designed with an eye on easy operations and cleaning; optimum lamp spacing, uniform flow field, and significant efficiency advantages amongst others. The photo catalytic reactor is also used for derivatisation of Aflatoxins and enhanced detection.

The MF-V6G photochemical reactor makes photochemistry accessible. Eliminating the problems of traditional batch photochemistry, the MF-V6G photochemical reactor allows the full potential of photochemistry to be exploited. It offers safe, precise, efficient, consistent and scalable photochemistry under continuous flow operation.

The narrow channel dimensions of flow reactors provide opportunities to ensure a uniform irradiation of the entire reaction mixture. Consequently, photochemical reactions can be substantially accelerated and scaled to higher quantities compared with batch reactors. Flow chemistry is also the technology of choice for transformations involving multiple phases. The high surface-area-to-volume ratios are a consequence of the small reactor size, leading to efficient mass transfer between two (or even three) phases. In case of gaseous reagents, flow reactors further offer the opportunity to control the stoichiometry of gasses with mass-flow controllers and are easily pressurized, which increases the solubility of gasses in the reaction mixture.

Concerning the light input we count on energy-efficient LED technology. The small size of the LEDs and their relatively low waste heat allow for a targeted adaption of the lighting units to any particular microreactor class. A further special advantage of these light sources is their quasi-monochromatic light

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emission, allowing a very selective excitation of the photochemically active material.

Salient features of photochemical reactors

· Available in integrated multilayer glass construction for mixing, reaction & heat transfer
· Micro channel with modular system to connect multiple reactors in series or parallel
· Suitable for various liquid-liquid, gas-liquid homogeneous & multi phase reactions
· Useful in photochemical & UV induced reactions
· Specially designed micro reactors from Microflu™ microchannel reactors used in various photochemical and UV induced reactions.
· Compatible with all reagents except hot concentrated alkali, molten alkali metal, hot concentrated H3PO4, HF, and strong corrosive agent, it can run stably for a long time.
· Multi-wavelength array LED light sources are available: 285nm, 295nm, 310nm, 365nm, 395nm, 405-425nm, 450-475nm (blue light), 520-550nm (green light), 4000K, 6000K, etc.
· The "T-shaped" fixture better reduces the distance between the light source and the reactor, making it easier to disassemble and fix the light source.
· Optional single-sided or double-sided reaction modules, flexible and variable combination design reduces process development costs.
· High-efficiency liquid-cooled heat dissipation design extends LED life.
· Stable light source ensures experimental repeatability.

The continuous flow photochemical reactor is not suitable for the reaction conditions and conditions as follows:

· Liquid-liquid two-phase, gas-liquid two-phase, and multi-phase reactions require higher mixing, but the reaction rate is extremely low (eg: flow rate ≤ 0.1ml/min).
· There are solids in two or more phases, or solids are generated, and cannot be dissolved by solvents, or the solid content exceeds 5% after dissolution, and the particle size is greater than 50 microns.
· Gas-liquid two-phase, the pressure required in the process exceeds the pressure limit of 20bar.

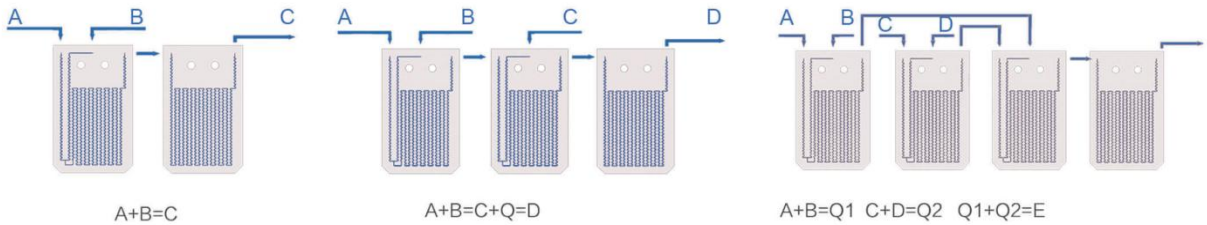
Reaction type(Technological Process)

The free combination modular system configuration can connect multiple reactors in series or in parallel to realize one-step and multi-step synthesis reactions. The highly flexible modular design ensures that it can adapt to the requirements of various processes.

Series: used to delay the residence time and ensure the reaction conversion rate meets the technical requirements.

Parallel connection: used to increase production capacity to ensure that the production demand is guaranteed while the conversion rate is reached.

A+B=C (one-step series connection) A+B=C+Q=D (multi-step series connection) A+B=Q1 C+D=Q2 Q1+Q2=D (multi-step series connection + series connection).



MF-V6G photochemical reactors specifications

Flow rate: 0.5-3L/min (up to 180kg/h)

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Flexible reactor volumes: 80ml or 200ml
Wetted materials: Glass,PFA, PFA & FFKM Or 316L
Dimensions: 290×290×21mm

MF-V9G photochemical reactors specifications

Flow rate: 0.1-100ml/min (up to 6kg/h)
Flexible reactor volumes: 80ml or 200ml
Wetted materials: Glass,PFA, PFA & FFKM Or 316L
Dimensions: 152.4x152.4x 11mm

MF-V6G&V9G photochemical reactors technical characteristics

· Available in integrated multilayer glass construction for mixing, reaction & heat transfer

· Micro channel with modular system to connect multiple reactors in series or parallel

· Suitable for various liquid-liquid, gas-liquid homogeneous & multi phase reactions

· Useful in photochemical & UV induced reactions

· Specially designed micro reactors from Microflu™ microchannel reactors used in various photochemical and UV induced reactions.

· Compatible with all reagents except hot concentrated alkali, molten alkali metal, hot concentrated H3PO4, HF, and strong corrosive agent, it can run stably for a long time.

Specifications of MF-V6 photochemical reactors

<table>
<tr><th colspan="5">Continuous Flow Photochemical Reactors</th></tr>
<tr><td>Model</td><td>MF-V6G-M</td><td>MF-V6G-M(9)</td><td>MF-V6G-M(S)</td><td>MF-V6G-M(S9)</td></tr>
<tr><td rowspan="6">Technical Parameters</td><td colspan="4">Material:Borosilicate glass</td></tr>
<tr><td>Volume：6mL</td><td>Volume：18mL</td><td>Volume：3mL</td><td>Volume：9mL</td></tr>
<tr><td colspan="4">Two-in-one-out hybrid module, can be connected in series with one-in and one-out modules to extend the residence time</td></tr>
<tr><td colspan="4">Design temperature (°C)：-30℃-280℃</td></tr>
<tr><td colspan="4">Process side pressure：0-20bar Heat exchange side pressure：0-5bar</td></tr>
<tr><td>Double layer process side + single layer heat exchange side （2+1）315nm-Visible light transmittance90 %</td><td>Double layer process side + single layer heat exchange side （2+1）315nm-Visible light transmittance90 %</td><td>Single layer process side + single layer heat exchange side （1+1）315nm-Visible light transmittance90 %</td><td>Single layer process side + single layer heat exchange side （1+1） 315nm-Visible light transmittance90 %</td></tr>
<tr><td>Number of light sources</td><td>Double-sided light source</td><td>Double-sided light source</td><td>Single-sided light source</td><td>Single-sided light source</td></tr>
<tr><td rowspan="2">Hoder</td><td colspan="4">Material：PFA（Holder）+PA66(Insulation）</td></tr>
<tr><td colspan="4">O-ring Material：FFKM+Viton 75</td></tr>
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	Design temperature (°C)：-25℃-195℃
Blue light source	LED light source
	Light source band：450-475nm
	Power：80-200W
UV light source	LED light source
	Light source band： 285nm（280-290） 295nm（290-300） 310nm（305-315） 365nm(360-370) 405-425nm
	Power：80-200W
4000K Light source	LED light source
	Light source band：4000K
	Power：80-200W
6000K Light source	LED light source
	Light source band：6000K
	Power：80-200W
Other	Pump/heat exchange/temperature measurement system module
Features/Advantages	Available in integrated multilayer glass construction for mixing, reaction & heat transfer; Micro channel with modular system to connect multiple reactors in series or parallel; Suitable for various liquid-liquid, gas-liquid homogeneous & multi phase reactions; Useful in photochemical & UV induced reactions;

Applications

The advantages associated with visible light photocatalysis resulted in various applications in medicinal chemistry, including drug discovery, bioconjugation, late-stage C–H functionalization, and isotopic labeling .

·Photo chlorination

·Production of Vitamin D

·Photo alkylation

·Artemisinin production (anti malarial drug)

·Production of E-caprolactame

·Water Splitting

·Water treatment

·Pharmaceuticals industry

·Research and development laboratories

·Educational institutes

·Alternative Energy

·Environmental Engineering

Possible photochemical applications include

·in situ generation of singlet oxygen

·photooxidation

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·cis-trans isomerization

·fluorination

·cyanation

·carbon-carbon bond formation via diazonium chemistry

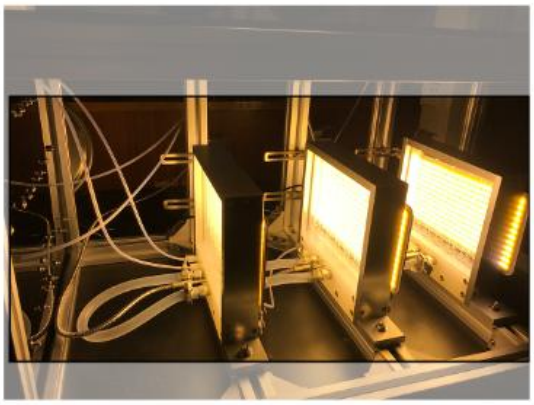
·nanoparticle manufacturing

Continuous reactions include:

·Ring-opening

·Photo-redox

·Photo-oxidation



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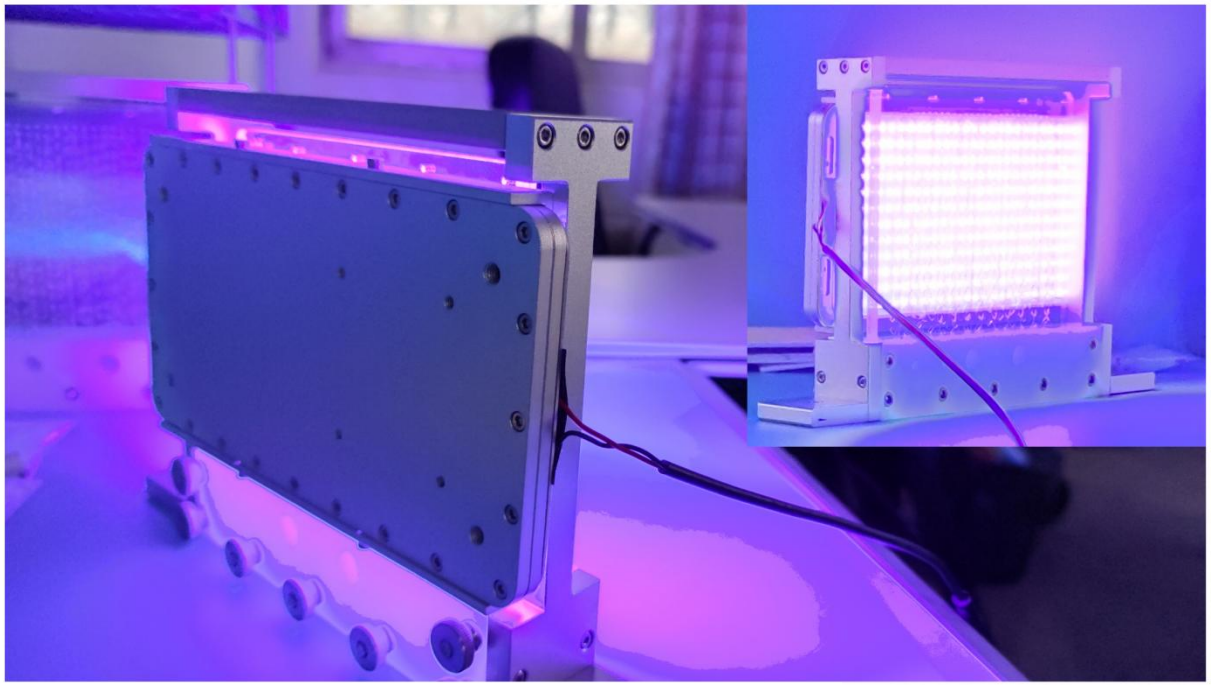

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