DESIGN OF A MICROFLUDIC DEVICE SYNTHESIZING GOLD NANORODS

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In this paper, we propose a microfluidic device synthesizing Au nanorods based on photochemical reduction method. It is expected that we can achieve high uniformed Au nanorods in size and shape through the microfluidic device based synthesis.

In the microfluidic device, we applied passive mixers to achieve more effective chemical reactions for Au nanorods synthesis. We also demonstrate effective passive mixer designed by the finite element method (FEM) simulation study.

As Au nanorods synthesis methods, seed particle growth method and photochemical reduction method are well known methods. Unlike the seed particle growth method, the photochemical reduction method is superior in the following points: it allows rapid chemical reaction; it is easy to control the aspect ratio of Au nanorods; it is possible to synthesize excellently monodisperse Au nanorods [1]. In orde to improve and control the uniformity in size and shape of Au nanorods, microfluidic devices based on seed particle growth method have been proposed [2]. However, a microfluidic device for Au nanorods synthesis based on photochemical reduction method has not been reported yet.

A schematic view of our microfluidic device for Au nanorods synthesis based on photochemical reduction method is shown in Fig. 1. It consists of PDMS layer having microchannel, inlets and outlet, 4 inch glass wafer for lid of PDMS layer, and micro UV-LED array. The microfluidic device is embedded in the jig. The 1 mm wide and 16 mm long microchannel in the PDMS layer is fabricated by pattern transferring from Si mold. The micro UV-LED array is placed at the bottom of the outlet chamber, in which Au nanorods will be grown. In Fig. 2, the simulation results of 6 chemicals mixing injected into inlets in turn for Au nanorods synthesis are shown. At outlet chamber, finally $3[Au[I]Br_2]^-$ ions are gathered, which will be grown to Au nanorods by irradiating UV light from UV-LED array.

The magnified top and cross sectional views of the mixing simulation results after mixing the $HAuCl_4$ and $C_{19}H_{42}BrN$ are shown in Fig. 3. Owing to the mixing was not sufficient, we designed and evaluated passive mixers having obstacles in the microchannels. As obstacles, we evaluated 4 different shapes such as circle holes, thin barrier, wide barrier and triangle.

The mixing simulation results with cross sectional views for the passive mixer having thin barrier obstacles is shown in Fig. 4. Moreover, the mixing simulation results for other type are also summarized in Fig. 5. Finally, the mixing simulation results are shown in Fig. 6 for microfluidic device having passive mixers using thin barriers.

Our proposed microfluidic device for Au nanorods synthesis will be fabricated and verified in near future.

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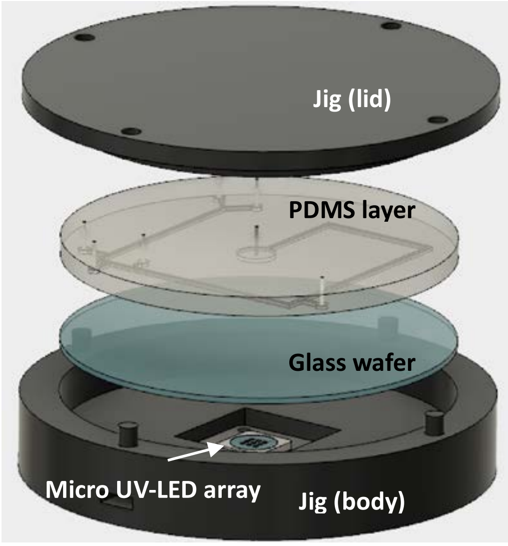

Fig.1 Schematic view of the microfluidic device for synthesis of Au nanorods.

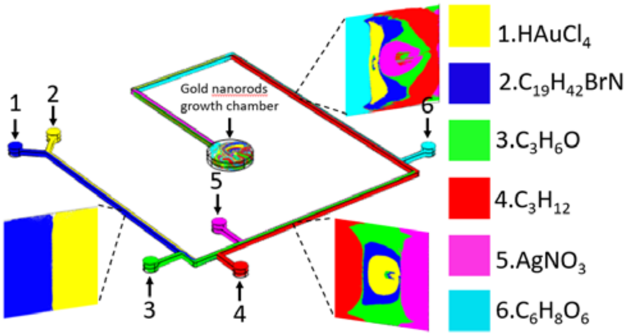

Fig. 2 Mixing simulation results of 6 chemicals for Au nanorods synthesis. Each chemical from 1 to 6 is injected into inlets from 1 to 6 in turn, respectively.

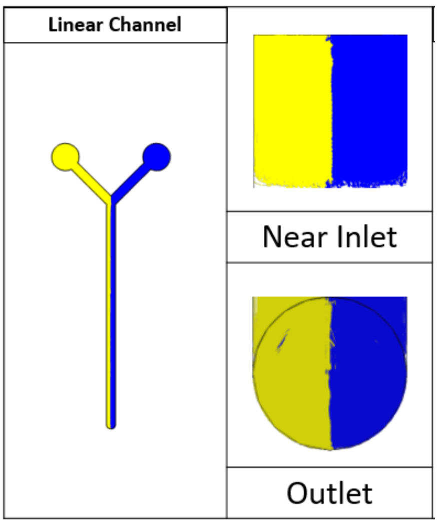

Fig. 3 The magnified top and cross sectional views of a part of microchannel shown in Fig. 2 after mixing of the chemical 1 and 2.

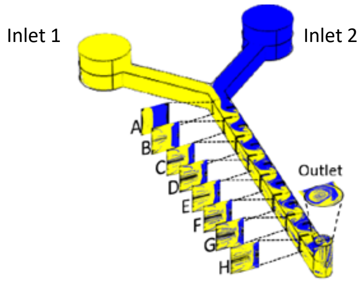

Fig. 4 The mixing simulation results of a part of microchannel with a passive mixer having thin barriers.

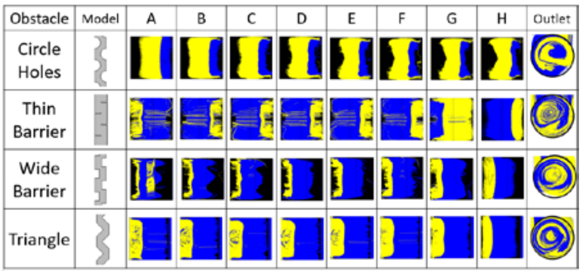

Fig. 5 Simulated cross-sectional views of passive mixers. The A-H indicates the locations as shown in Fig. 4.

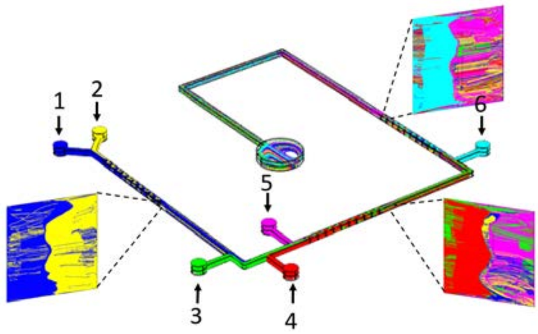

Fig. 6 Simulation results of the microfluidic device with passive mixers using thin barriers for Au nanorods synthesis.

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