

cation of a structure of copolymer film in microchannel", p. 37, preliminary papers for lecture by Yoshinori Shimizu et al. in the 5th Chemical and Microsystem Society, published in 2002). However, it was difficult to form such film along a flowing direction of fluid unless the fine channel had a short length such as about 1 mm or less. Accordingly, it was difficult to form a continuous film along the following direction of fluid in a longer fine channel.

[0020] Further, there has been attempted a technique of contacting adjacent laminar flows of fluid in a fine channel by supplying a plurality kinds of fluid in mutually opposite directions or by crossing them at an arbitrary angle (see, for example, a non-patent document 4: "Development in the formation of three-dimensionally crossing multilayer streams", p. 55, preliminary papers for lecture by Akihide Hibara et al. in the 3rd Chemical and Microsystem Society, published in 2001). In such technique, there is expectation about the capability of changing a balance in a chemical reaction or solvent extraction by avoiding the flow of the same direction between adjacent flows of fluid. The above-mentioned non-patent document 4 shows an experimental result in which a fine channel made of glass having a length of about 1 mm or less wherein a side portion of the inner wall of the fine channel which has originally hydrophilic properties is modified by trichlorooctadecylsilane which is generally known as a hydrophobic modifier, is used. Thus, it was difficult to make adjacent laminar flows of fluid contact in the fine channel by supplying them in mutually opposite directions or crossing them at an arbitrary angle. In particular, it was very difficult to realize the above-mentioned operations in a fine channel having a longer distance. There was no possibility of conducting experiments for verification as to whether or not a balance in a chemical reaction or solvent extraction could be changed by such operations.

[0021] Further, in order to modify the fine channel as proposed in the non-patent document 4, a plurality of processes such as a pre-washing process, a modifier supplying process, a modifier stabilizing process, a post-washing process and so on were needed. Such fine channel modification required much time and cost, and the durability of the modifier was only about 1 to 4 weeks. Accordingly, there was no fine channel capable of assuring a semipermanent supply of fluid.

[0022] Further, in the fine channel as shown in FIG. 1, a chemical reaction took place mainly at the fluid boundary 3 (see, for example, a non-patent document 5: "An integration type microreactor chip", p. 99-105, vol. 20 by Fujii et al., published in 2001). Accordingly, the diffusion effect of molecules brought only the accumulation of a reaction product at the fluid boundary, and the above-mentioned effects of providing an effective chemical reaction as a feature of the chemical reaction in a fine space, a rapid solvent extraction/separation and control of a side reaction, could not sufficiently be obtained. Although the diffusion time of molecules can further be shortened by narrowing the width 9 of the fine channel, and the accumulation of a reaction product at the fluid boundary can be suppressed as described before, the pressure loss increases as the width of the fine channel is narrowed. Accordingly, the fluid supply itself becomes difficult and it was not realistic.

[0023] Further, in an attempt of disturbing positively the fluid boundary to accelerate the mixing, there is a possibility

of obtaining an efficiency chemical reaction because a reaction product can uniformly be distributed in the fine channel. However, a fluid mixture became suspension whereby the reaction product could not easily be separated from the reaction phase, and effects of solvent extraction/separation and the suppression of a side reaction could not sufficiently be obtained.

[0024] In a chemical reaction using a catalyst according to a conventional technique, there are a non-uniform catalytic reaction in which a reaction product and a catalyst are in different phases and a uniform catalytic reaction in which a reaction product and a catalyst are in the same phase to proceed a catalytic reaction. As the catalyst used in the non-uniform catalytic reaction, a solid catalyst is often used. For example, liquid or gas containing a reaction product is supplied continuously to the solid catalyst to proceed a chemical reaction.

[0025] Accordingly, the non-catalytic reaction is advantageous in that operations of separating the catalyst and the reaction product are unnecessary and a large scale production is possible. However, it has disadvantages that the reaction efficiency is lower than that of the uniform catalytic reaction because the catalytic activity takes place only on the surface of the solid catalyst and the selectivity to the reaction product is poor.

[0026] On the other hand, the uniform catalytic reaction is advantageous in that the interfacial surface area of the catalyst to a reaction product is large because the chemical reaction generally takes place in a reaction vessel in which a catalyst and a raw material are mixed in a suspension state, whereby the reaction efficiency is better than that of the non-uniform catalytic reaction and the selectivity to the reaction product is good. However, operations to separate and recover the solvent, the catalyst and the reaction product by using a distillation or filtration technique after the completion of the reaction, are needed. Since the catalyst is generally soluble to the solvent, it is very difficult to separate for reuse the catalyst which is generally expensive.

[0027] Conventionally, as a technique of supplementing mutual advantages and disadvantages of the non-uniform catalytic reaction and the uniform catalytic reaction as mentioned above, there has been carried out a technique that a catalyst is supported on a carrier such as a polymer or an oxide to be non-uniformized, and after completion of the reaction, the carrier having the catalyst supported thereon is separated as it is. However, this technique had problems that the cost of an expensive catalyst was further increased by carrying the catalyst on the polymer or the oxide; an unstable state was caused thermally or chemically; a rapid elimination of heat as an advantage of the catalyst was difficult and reaction efficiency became worse.

[0028] Further, there has generally been carried out a chemical reaction in which an enzyme (a biocatalyst), as a kind of catalyst, contained in an aqueous phase is mixed with a substrate contained in an organic phase so that the substrate is hydrolyzed or esterified by the enzyme. In this case, there were problems that the activity of the catalyst was lost because the structure of the enzyme was changed mechanically when the mixing of the aqueous phase and the organic phase was carried out by mechanically stirring in order to increase the reaction efficiency, and the activity was