hydrophilic or hydrophobic properties. For example, it is preferred that in a case where the fluid to which the fine particles are incorporated, is a hydrophilic medium such as water, ethanol or the like, the fine particles modified so that the surface of the fine particles has a functional group such as a hydroxyl group or a carboxyl group to have hydrophilic properties, are used, and in a case where the fluid to which the fine particles are incorporated is a hydrophobic medium such as hexane, ethyl acetate or the like, the fine particles modified so that the surface of the fine particles has a functional group such as an octadecyl group or a butyl group to have hydrophobic properties, are used. Thus, it is possible to suppress the fine particles incorporated in a kind of fluid from moving acrossing the fluid boundary to another kind of fluid which flows adjacently with respect to the fluid boundary whereby the fine particle-containing fluid can be stirred while the fluid boundary can be kept stably by the presence of the partition walls arranged with intervals.

[0114] **FIG. 20** is a diagram showing how the fluid is stirred by the function of the fine particles in the fine channel in a case that two kinds of fluid are supplied to the fine channel and fine particles are incorporated only in a kind of fluid. As shown in **FIG. 20**, fine particles **80** impinge on the inner wall of the fine channel **19** or collide with each other to change the moving direction **81** of the fine particles whereby a stirring effect is obtainable. Other than the case as shown in **FIG. 20**, the fine particles may be incorporated into two kinds of fluid to stir these kinds of fluid.

[0115] In **FIG. 20**, numeral **18** designates a bottom surface of the fine channel, **27** a flowing direction of fluid, **51** a side face of the fine channel and **52** a fine channel substrate.

[0116] Conventionally, chemical operations such as mixing, chemical reaction, solvent extraction, separation, catalyst recovery or the like were conducted separately using beakers, flasks etc. On the other hand, the fine channel device of the present invention allows chemical operations such as mixing, chemical reaction, solvent extraction, separation, recovery etc. all together in the fine channel. In particular, as a chemical reaction to which the chemically operating method using the fine channel device according to the present invention, there is a multiphase type catalytic reaction.

[0117] As a catalyst generally used, there are an acid-base catalyst such as oxonium ions, hydroxide ions or the like, and a transition metal complex having nickel palladium, copper titanium etc. as the central metal. Further, as a kind of catalyst, there is an enzyme being a protein produced in a living organism, which is a so-called biocatalyst such as lipase, trypsin, chymotrypsin, cathepsin, fumarate hydratase, laccase etc.

[0118] In the chemically operating method of the present invention, the fluid discharged from an outlet port and returned again to an inlet port may be the before-mentioned catalyst-containing fluid. By circulating the fluid, it is possible to recover a very expensive catalyst in a degree that the catalytic activity does not lost, and reuse the recovered catalyst. In a chemical reaction using an enzyme being a biocatalyst, an aqueous phase containing an enzyme and an organic phase containing a substrate are mixed with a stirring device such as a stirrer to produce suspension whereby the enzyme reacts effectively with the substrate. However, the enzyme is generally apt to lose its activity due to a physical action such as mechanically stirring or apt to lose due to the enzyme being suspended in the organic phase. On the other hand, the chemical reaction between the enzyme and the substrate can effectively be performed by using the fine channel device of the present invention because the interfacial surface area of the fine channel is large and the molecule diffusion distance is short by making the enzyme-containing aqueous phase and the substrate-containing organic phase flowing in the fine channel as laminar flows, contact mutually at the fluid boundary so that the enzyme contacts with the substrate without any mechanically stirring operation. Further, since the activity of the enzyme does not lose because of no physical action such as mechanically stirring or no suspension of the enzyme and the organic phase, the enzyme can easily be separated and recovered for reuse without losing its activity. Specifically, the enzyme-containing aqueous phase and the substrate-containing organic phase are separated in the fine channel; the organic phase is fed to an outlet channel to take out the substrate subjected to a catalytic reaction; the aqueous phase is fed to the outlet channel to take out the aqueous phase discharged from the outlet port, and the aqueous phase is again supplied to the inlet port to which the enzyme-containing aqueous phase has been supplied. Such chemically operating method can be accomplished only by using the fine channel device of the present invention.

[0119] In the chemically operating method according to the present invention, as shown in **FIG. 19**(*a*), chemical operations such as mixing by diffusion, chemical reaction, solvent extraction, separation or recovery may be carried out by forming laminar flows of two phases of fluid comprising a catalyst-containing fluid **78** and a substrate-containing fluid **79** in a fine channel **19**, or such chemical operations may be carried out by forming laminar flows of three phase of fluid: a catalyst-containing fluid **78** and two kinds of substrate-containing fluid **79** which are supplied to both sides of the catalyst-containing fluid **78** in a flowing direction as shown in **FIG. 19**(*b*); such chemical operations may be carried out by forming laminar flows of three phases of fluid comprising a substrate-containing fluid **79** and two laminar flows of catalyst-containing fluid **78** which are supplied to flow both sides of the substrate-containing fluid **79** in a flowing direction as shown in **FIG. 19**(*c*), or such chemical operations may be conducted by forming laminar flows of multi-phases of fluid comprising a plurality of laminar flows of catalyst-containing fluid **78** and a plurality of laminar flows of substrate-containing fluid **78** which are supplied in an alternately contacting state in a flowing direction **27** as shown in **FIG. 19**(*d*). Here, a plurality of same or different kinds of substrates and a plurality of same or different kinds of catalysts may be used.

[0120] There is a so-called a phase transfer catalyst as one of an extensive group of catalyst. Description will be made as to a two-phase reaction system using a quaternary ammonium salt as an example of the phase transfer catalyst. **FIG. 14** shows a concept of the mechanism of a reaction in which CN^- is used as a nucleophilic anion **62**, and (R—X) as an alkyl halide **63** is exchanged for (R—CN) as a nitrile **64** wherein (Q^+X^-) as a quaternary ammonium salt **65** is used as a phase transfer catalyst.

[0121] In a reaction system constituted of an aqueous phase containing Na^+CN^- composed of a nucleophilic anion and a non-polar organic phase containing (R—X) as an alkyl