[0053] The term passage refers to the region within a valve that is obstructed by a mass of TRS with the valve fully closed. When the valve is fully open, the passage is the region through which material, such as a liquid, can pass through the valve from an upstream location to a downstream location. Thus, surfaces of the valve reservoir are not part of the passage because material in the passage is preferably excluded from passing into the reservoir. The "mass of TRS" refers to an amount of TRS sufficient to substantially obstruct the valve passage, thereby substantially preventing the passage of material through the valve. Substantially preventing the passage of material prevents the passage of an amount of material that would undesirably deplete the volume of a micro-droplet located upstream from the valve. Similarly, substantially preventing the passage of material prevents upstream material from adversely impacting micro-droplets located downstream from the valve. For example, the concentration of or pH of the downstream droplet remains essentially unchanged when upstream material is blocked by a closed valve. Preferably, a closed valve completely prevents the passage of any liquid or particle adjacent the valve.

[0054] Referring to **FIG.** 2*b,* an open state of valve **50** is shown in which TRS **56** has been essentially fully retracted into reservoir **55** to open passage **68**, thereby permitting passage of material through valve **50** from at least one of the first and second channels to the other. By essentially fully retracted, it is meant that essentially all of TRS **56**, which had obstructed passage **68**, is retracted into reservoir **55** rather than remaining in passage **68** or dispersing downstream of valve **50**. Upon fully retracting TRS **56**, not more than about 10%, preferably not more than about 5%, and most preferably not more than about 2% of TRS **56** is left behind in passage **68** and dispersed downstream of valve **50**.

[0055] The opening motion is preferably driven by decreasing the pressure upon end **30** of TRS **57** relative to the pressure acting upon TRS abutting portion **70**. The decreased pressure preferably occurs upon the contraction of a fluid, such as gas **32** present in actuating portion **34** of reservoir **55**. The contraction of gas **32** can be obtained by cooling the gas to decrease the gas temperature and volume. Gas **32** is preferably cooled by actuating a cooler, such as a Peltier cooler in thermal contact with gas **32**. The cooler is preferably integral with the substrate comprising valve **50** and with heat source **36**. It should be understood, however, that the cooler can be located in a separate device that receives the substrate during operation.

[0056] The preferred open state of valve **50** permits passage of material being transported from first channel **52** to second channel **54**. An opening distance **92** from abutting TRS portion **70** to wall **72** is sufficiently large to allow material to be passed through passage at a desired material transport rate. In the fully open state, opening distance **92** is preferably at least as great as distance **82** of second channel **54**. It should be understood, however, that valve **50** can be operated in a partially open state, in which opening distance **92** is less than distance **82**.

[0057] Valve **50** operates to close passage **68** when a closing motion of TRS **56** moves TRS abutting portion **70** across passage **68** to abut wall **72**. The closing motion is preferably driven by pressure acting upon end **30**. The pressure is obtained by the expansion of a fluid, such as gas **32**. The expansion of gas **32** is preferably obtained by increasing the temperature of the gas by actuating a heat source **36** in thermal contact with gas **32**. Heat source **36** is preferably integral with the substrate comprising valve **50**. It should be understood, however, that the heat source can be located in an auxiliary device that accommodates the substrate during operation.

[0058] Referring to **FIGS.** 4*a* and 4*b,* a valve **50'** having a different opening operation is shown. The opening of valve **50'** is actuated by changing the temperature of at least a portion of a mass of TRS **56'**, which obstructs passage **68**. Actuation of a heat source **37'**, which is in thermal contact with TRS **56'** provides the thermal energy to raise TRS **56'** from a first temperature to a second, preferably higher temperature. The second temperature is preferably sufficient to allow TRS **56'** to melt or disperse, thereby opening passage **68**. The portion of TRS **56'** that is raised to the second temperature is sufficient to open passage **68**.

[0059] Rather than retracting into a reservoir **55'**, at least about 30%, preferably at least about 75%, and more preferably at least about 90% of TRS **56'** enters second channel **54**, downstream from valve **50'**. Thus, a valve of type **50'** is a gate-type valve as distinguished from valve **50** in which material retracts into a reservoir to open the valve. The entry of TRS **56'** into the downstream channel is preferably assisted by the application of excess upstream pressure against TRS **56'**. The upstream pressure can be provided using a source of gas pressure in fluid communication with the upstream channel.

[0060] Although at least a portion of TRS **56'** enters the downstream channel upon opening passage **68**, gate type valves, such as valve **50'**, of the invention can be returned to the closed state once opened. For example, additional TRS can be made to flow from the reservoir associated with the gate valve into the passage by heating at least the associated reservoir.

[0061] Heat source **37'** is preferably configured to heat a downstream length **45** of second channel **54'** to a temperature sufficient to prevent dispersing or melting TRS from obstructing second channel **54'**. Length **45'** is at least 50% and preferably at least 75% as long as a length of passage **68** obstructed by TRS **56'**. Heat source **37'** heats the walls of the adjacent portion of the downstream channel to a temperature sufficient to at least often and preferably melt or disperse TRS **56**. Thus, as seen in **FIG.** 4*a,* a portion of dispersed or melted TRS **56'** can be deposited within downstream channels in small volumes TRS **59'** that have a size insufficient to obstruct a downstream channel. TRS **56'** can also be formed of a material that opens passage **68'** without melting. For example, in one alternative embodiment, the obstructing TRS is formed of an agglomeration of particles. Upon a transition to a higher temperature, the agglomerated particles disperse downstream thereby opening the valve.

[0062] Valve **50'** includes a reservoir **55'**, which allows TRS **56'** and **57'** to be introduced into passage **68'** and reservoir **55'**, respectively. To load TRS in passage **68'**, the passage and reservoir are heated, such as by an external heat source, and TRS is introduced into an access port **40'**. Once the TRS has just obstructed the passage, the external heat source is removed. TRS **56'** then obstructs passage **68'** of valve **50'**, which operates similarly to valve **50** by preventing leakage in response to upstream pressure.