both top and bottom are aligned in the same direction with respect to flow, and the surface feature legs are converging along the flow direction.

[0140] Cis B refers to an alignment of a two or more sided microchannel with surface features where the features on both top and bottom are aligned in the same direction with respect to flow, and the surface feature legs are diverging along the flow direction.

[0141] Fanelli refers to a discontinuity or small disconnection of the legs of the surface features that are otherwise connected. The discontinuity is less than 20% of the microchannel width, and preferably less than 10% of the microchannel width. FIG. **3***h* shows a Fanelli for a SFG-0 feature pattern, where the apex is removed to help alleviate either dead spots or reduced velocity regions in the main channel flow path that result from a change in angle. The disconnected location of a Fanelli between two surface features may be also dislocated along the length direction of the channel, where half of a v starts and stops at two axial locations along the channel lenght and the other half of a v starts and stops at an off set position either slightly above or below the start and stop point of the first half of the v.

[0142] Surface feature geometry 1 (SFG1) is represented in FIG. **3***b* and contains features that alternate in orientation or angle along each microchannel wall. For this geometry, five or more asymmetric chevrons (where one feature leg is longer than a second feature leg) are placed with the apex of the feature placed one-third of the microchannel width, the features are then followed by two filler features (noting that fewer or more filler features could be used), and then followed by 5 or more asymmetric features where the apex of the chevron is roughly two-thirds along the width of the microchannel. This pattern is repeated several times. As shown, the pattern on the opposing microchannel wall is in the trans-orientation, where the features are not mirror images.

[0143] SFG-2 is a design where each angle continuously changes along the feature run length, as shown in FIG. **3***c* (top down view), where the flow in the main channel adjacent to the features is from left to right or from right to left. The feature could be advantageous in minimizing flow disturbance at the leading edge of each feature since the shape is more aerodynamic. The substantially continuously changing angle could also change from a positive to a negative value along the feature run length.

[0144] A top view of the SFG-3 surface feature pattern is shown in FIG. **3***d*, including a view of both top and bottom faces, and how the two overlap when seen from above. This pattern can be repeated as many times as necessary to fill the desired length. The main characteristic of SFG-3 is the repetition of the "checkmark" shape of SFG-5

[0145] The feature pattern SFG-4 is a simple diagonal slot with only one feature leg per surface feature (such as shown in the right hand side of FIG. **3***e*). The pattern SFG4 is substantially similar to many single angle diagonal features described in the prior art and is particulary ineffective for mixing and unit operations, especially for one wall only patterns or two-wall patterns with a trans orientation. Flow in this pattern has a decreasing fraction of residence time spent within the features as the Reynolds number increases.

[0146] Surface feature geometry 5 is represented by a series of checks, where the apex of the check is such that the run length of one leg of the feature is roughly half of the run length of the other leg. Groups of 4 or more of these "check" shaped features can be arranged in many different combinations, including the three shown in FIG. **3***f*. These groups of checks may have different orientations relative to one another, or all have the same orientation, forming a continuous pattern of checks along the surface. Each combination or variety of SFG-5 pattern will yield different mixing characteristics. FIG. **3***f* illustrates three different alternative layouts for SFG-5 surface feature geometry patterns.

[0147] Surface features preferably have at least one change in the angle of orientation. Surface feature geometry 6 (SFG 6) contains three surface feature legs and has two changes in the angle of orientation from positive to negative with respect to the direction of flow, as shown in FIG. **3***g*. This imparts aspects of both an "A" and a "B" type flow direction to the flow in the main channel, as two of the feature legs are convergent with respect to each other along the bulk flow direction and two of the feature legs are divergent with respect to each other along the bulk flow direction.

[0148] "House" refers to an entrance leg to a surface feature where one or more legs runs parallel with the main channel bulk flow direction before turning at an oblique angle to the direction of flow (see FIG. **3***i*). The angle may optionally be more rounded than that shown in the figure below. The house may also be preferentially at an angle other than 90 degrees such that it improves the advection of flow into the active surface features.

[0149] A sharks tooth pattern represents a single legged surface feature with a varying span from one end to the other (see, for example, FIG. **3***j*). The leg may be at any angle relative to the main channel bulk flow direction, and multiple teeth at different angles may populate a microchannel wall.

[0150] FIG. **3***e* illustrates surface features with a 60 degree angle for SFG-0, a 75 degree angle for SFG-0, and a 45 degree angle for the SFG-4 pattern, where the angle is defined relative to a horizontal plane that bisects the microchannel cross section orthogonal to the main flow direction.

[0151] Other embodiments of multiple-legged surface feature geometries have different angles and or lengths for each leg, or for some of the legs, or groupings of 5 or more identical surface features as shown in FIG. **3***k*. Repetition of groupings of surface features also provides potential advantages during fabrication. For example, when stamping features from thin sheets, stamping tools can be made to stamp multiple features at once.

[0152] Layered surface features: Layered surface features are formed in one or more wall of a main channel. The layered surface feature wall is formed by stacking adjacent layers with different surface feature geometries in them (see FIG. **4***a*), and aligning the columns of features such that the two stacked together make a more complex three dimensional feature. For layered features, the surface features in all layers except the layer farthest from the main channel must be through features. Alternately, the identical surface features made as through features in a thin sheet may be made deeper by stacking sheets of identical surface features directly on top of one other and aligning the features in each sheet.