then the orthogonal (that is, orthogonal to the bulk flow direction in the main channel) projection of each perimeter should be used in determining whether features are like features.

[0062] The length and width of a surface feature are defined in the same way as for a microchannel. The depth is the distance which the feature sinks into the microchannel surface; it is the same direction as microchannel height and microchannel gap. In one preferred embodiment, comprising a stacked and bonded device with surface features on the sheet surfaces, the surface feature depth corresponds to the direction of stacking. These dimensions of the surface features refer the maximum dimension of a feature; for example the depth of a rounded groove refers to the maximum depth, that is, the depth at the bottom of the groove.

[0063] Depth of feature: the mean (or average) distance from the plane where the surface feature intersects the main channel to the bottom of the surface feature (the bottom being the plane tangent to the surface feature edge which is farthest from and parallel to the plane where the surface feature intersects the main channel).

[0064] Width or span of feature: the nominal value of the shortest dimension of the surface feature in the plane where the surface feature intersects the main channel, or distance from surface feature edge to surface feature edge.

[0065] Run length of feature leg: the nominal value of the longest dimension of the surface feature leg in the plane where the surface feature intersects the main channel.

[0066] (Surface) feature leg: a portion of the feature having no discontinuity or change in sign of in slope along the run length relative to the main channel mean bulk flow direction.

[0067] Spacing of repeated features: the average distance between repeated features in the direction perpendicular to the run length of the feature leg

[0068] Angle of feature: The angle between the direction of the run length of the surface feature leg and the plane orthogonal to the mean bulk flow direction in the main channel. A surface feature preferably has more than one angle. The angle may change from one greater than zero to one less than zero. The angle may change continuously along the feature in either a continuous or discontinuous manner.

[0069] Orientation of feature: the orientation of a section of repeated surface features relative to identical features on an adjacent or opposite wall in the main channel.

[0070] Flow orientation relative to feature: the direction of the mean bulk flow in the main channel relative to the orientation of a feature recessed in a given wall of the main channel. The designation A is used to designate a mean bulk flow direction in the main channel for which the run length of each leg of a two-legged surface feature tend to converge or come closer together along the main channel mean bulk flow direction. The designation B was used to designate the opposite flow direction relative to the surface feature. For features with more than two-legs, an A orientation would refer to a mean or average or net feature run length that is more converging than diverging with respect to the mean direction of flow. Conversely, a B orientation refers to a mean or average or net feature run length that is more diverging than converging with respect to the mean direction of flow.

[0071] "Capillary features" are features associated with a microchannel that are used to hold liquid substances. They are either recessed within a wall of a microchannel or protrude from a wall of the microchannel into the flow path that is adjacent to the microchannel wall. The features create a spacing that is less than 2 mm, more preferably 1 mm or less, still more preferably a spacing of 500 μm or less. The features have at least one dimension that is smaller than any dimension of the microchannel in which they are situated. The capillary features may be at any angle for a slot type structure or an array of holes or any other recessed or protruded structure used to retain a liquid by capillary forces.

[0072] A "catalyst material" is a material that catalyzes a desired reaction. Nonlimiting examples of catalyst materials include metals, metal oxides, and acidic sites.

[0073] A "catalyst metal" is the preferred form of catalyst material and is a material in metallic form that catalyzes a desired reaction. Particularly preferred catalyst metals are Pd, Rh, Re, Ir, and Pt.

[0074] A "chemical unit operation" comprises reactions, separations, heating, cooling, vaporization, condensation, and mixing.

[0075] A "contiguous microchannel" is a microchannel enclosed by a microchannel wall or walls without substantial breaks or openings—meaning that openings (if present) amount to no more than 20% (in some embodiments no more than 5%, and in some embodiments without any openings) of the area of the microchannel wall or walls on which the opening(s) are present.

[0076] "Interior microchannel" refers to a microchannel that is bounded on all sides by a microchannel wall or walls except for inlets and outlets, and, optionally, connecting holes along the length of a microchannel such as a porous partition or orifices such as connecting orifices between a fuel channel and an oxidant channel.

[0077] A "manifold" is a header or footer that connects plural parallel microchannels and is integral with the apparatus.

[0078] A "microchannel" is a channel having at least one internal dimension (wall-to-wall, not counting catalyst) of 1 cm or less, preferably 2 mm or less (in some embodiments about 1.0 mm or less) and greater than 100 nm (preferably greater than 1 μm), and in some embodiments 50 to 500 μm. Microchannels are also defined by the presence of at least one inlet that is distinct from at least one outlet. Microchannels are not merely channels through zeolites or mesoporous materials. The length of a microchannel corresponds to the direction of flow through the microchannel. Microchannel height and width are substantially perpendicular to the direction of flow of through the channel. In the case of a laminated device where a microchannel has two major surfaces (for example, surfaces formed by stacked and bonded sheets), the height is the distance from major surface to major surface and width is perpendicular to height. The "depth" of a surface feature is in the same direction as "height" of a microchannel.