near the microchannel wall. The features may be of any shape (rectangular, circular, trapezoidal, other) as long as they provide at least one critical dimension less than a defined parameter based on the fluid properties such that capillary forces are stronger than gravitational forces to prevent draining or slip along the microchannel walls.

[0166] Capillary features may be placed along the length of the microchannel at the desired location to create a uniform or tailored intrachannel distribution of a coating composition.

[0167] To promote good channel-to-channel uniformity, the same profile of capillary features are placed along every parallel microchannel in an array of microchannels. The features are preferentially aligned partly or fully normal to the direction of gravity to minimize draining with the direction of gravity. The features may be aligned at an angle with respect to the direction of gravity during draining. The features may be oriented parallel to the direction of gravity if they are short and discontinuous. On a microchannel wall, there are preferably three, five, ten, or more features in a group.

[0168] In one embodiment a tailored profile may leave more capillary features and thus more catalyst solution near the front of a reactor section where the demand for catalyst is higher. In another embodiment for the case of an exothermic reaction, such as a selective oxidation, the amount of catalyst placed or retained near the front of the reactor may be reduced to in turn reduce the amount of heat released and thus unwanted temperature rise. In a third embodiment, the location and size of capillary features may be tailored on the edge channels of a microchannel device such that the heat release is reduced near the device edge. For example, in a layer of a microchannel device, there may be a higher concentration of capillary features near the center of the layer than near an edge so that more coating is applied near the center of the device. Thus, on a layer comprising an array of microchannels with at least one central microchannel and two edge microchannels, in some embodiments the at least one central channel can have a higher concentration of capillary features than the concentration in either of the two edge channels; this can be reversed if greater catalyst concentration is desired along the edge. This may create an advantaged mechanical design wherein the local edge temperature is reduced near an area of high thermal strain. The capillary features may be used to control or tailor the process performance as measured in conversion and selectivity for a given capacity or flow rate per unit volume. The features may also be used to minimize mechanical strains in high strain regions of the apparatus by reducing the local heat release and thus reduce the resulting temperature gradient.

[0169] To retain a liquid (either catalyst precursor or other). The fluid is filled within a microchannel or an array of parallel microchannels and then drained while leaving behind fluid within the capillary features on the wall. The fluid may then be dried to leave behind active agent on the walls. The fluid may be aqueous based or comprising a solution or a slurry or a suspension of solid particles or liquid droplets, including nanoparticles, or it may be a polymeric solution, or any liquid coating composition.

Methods of Making Surface Features

[0170] Surface features can be made, for example, by laser etching; Electrical Discharge Machining (EDM) which uses a small diameter wire to make the intended feature by burning away a conductive base material; or stacking a sheet with through holes onto another sheet and then bonding the sheets together. The surface features may be partially etched within a sheet or be formed in a sheet as through features, which sheet is then placed adjacent to a solid wall. Alternatively, the surface features may be created by stacking two or more sheets with through features adjacent to a solid or etched sheet. The pattern and/or size and/or shape of the features may be different on the two or more stacked sheets of through features. Surface features may also be made by three-dimensional patterning processes, such as an SLS process where metal powder is selectively sintered to create intricate 3-D structures.

[0171] The surface features could be formed as through slots or holes in a thin metal shim that is stacked adjacent to a wall shim prior to diffusion bonding. The resulting structure would be similar to recessed features in a microchannel wall.

[0172] Surface features may be used to tailor mixing and/or the application of a catalyst or any other washcoating solution along the length of a microchannel wall. A greater concentration of surface features can be placed near a microchannel inlet (such as an inlet from a header) or, alternatively, relatively more can be disposed near a microchannel outlet. Thus, in some embodiments, a reaction microchannel, with one inlet and one outlet, has a greater density of capillary features near the inlet than near the outlet; or, conversely, has greater density of capillary features near the outlet than near the inlet.

Catalyst Coatings

[0173] Microchannels containing surface features can be coated with catalyst or other material such as sorbent. Catalysts can be applied onto the interior of a microchannel using techniques that are known in the art such as wash coating. Techniques such as CVD or electroless plating may also be utilized. In some embodiments, impregnation with aqueous salts is preferred. Pt, Rh, and/or Pd are preferrred in some embodiments. Typically this is followed by heat treatment and activation steps as are known in the art. Salts which form solutions of pH>0 are preferred. Other coatings may include sol or slurry based solutions that contain a catalyst precursor and/or support. Coatings could also include reactive methods of application to the wall such as electroless plating or other surface fluid reactions.

[0174] Coatings could also be applied onto microchannel walls by filling channels to the desired height with a liquid coating composition and removing volatile components (typically solvent) under reduced pressure. Care may need to be exercised to avoid bubbling defects.

[0175] Materials, such as metals, can be printed onto a microchannel wall (either flat or featured) by printing, preferably by techniques similar to ink jet printing. A printed metal pattern could also be used as a seeding material (catalyst) for the formation of electrolessly-deposited metal (preferably a patterned, electoless coating). Additionally or alternatively, selective etching and/or selective deposition techniques developed in the electronics industry can be used to provide subpatterning in surface features **52**. See FIG. **5**. This subpatterning is especially useful to enhance surface area for depostion of a catalyst, and/or direct selective