feature sinks into or protrudes from the microchannel surface. The width of a capillary feature is the direction perpendicular to both length and depth. In some embodiments, a coated section of a microchannel has a substantially straight length (height and width may be variable).

[0292] Measuring the coating thickness is performed ex situ by cutting the device into cross sections and taking SEM pictures to quantitatively measure the coating thickness.

[0293] Multiple features may be included within any given microchannel. Including features that protrude or recess at different depths into or out of the microchannel wall.

[0294] One example feature contains horizontal (gravity points down) recessed capillary features offset by angled recessed features. See **FIG. 9***a*. Horizontal features are especially preferred to create a stop for fluid draining by gravity down the microchannel walls. Not all capillary features however need to be horizontal to uniformly retain washcoat solution. The variations may be added to tailor the retention of washcoating solution (or any other liquid fluid solution that may be applied to the walls of a microchannel).

[0295] There are several parameters, which Include: Depth, width, and spacing for each feature. Any or all of these parameters may be varied throughout the channel in order to tailor the catalyst loading in specific section of the device. More complex patterns can be formed by grouping sub-patterns together. Each sub-pattern has its own set of parameters that can be controlled independently from each other set of sub-patterns, in order to maximize uptake and/or tailor the catalyst loading.

[0296] Capillary features may be used to tailor the application of a catalyst or any other washcoating solution along the length of a microchannel wall. More catalyst may be preferred near the reactor inlet, and thus deeper and/or more closely spaced recessed or protruded capillary features may be placed in this zone. Near the end of the reaction zone, less catalyst may be required as the reaction has proceeded near completion. It may be preferable to reduce the catalyst loading near the end of the catalyst section. Thus, in some embodiments, a reaction microchannel, with one inlet and one outlet, has a greater density of capillary features mear the inlet than near the outlet; or, conversely, has greater density of capillary features mear the outlet than near the inlet.

[0297] As shown in **FIG. 9***b*, the features may take the form of recessed or protruded dots, circles, hemispheres, cylinders, and the like. The spacing between protruded capillary features creates capillaries—preferably these spacings have the capillary dimensions described above.

[0298] **FIG. 9***c* shows alternating sections of protrusions and recessed areas. Capillary features may include straight, horizontal recessed channels or straight protrusions with straight capillary spacings therebetween. In another alternative, capillary features may include a square wave pattern.

[0299] **FIG. 9***d* illustrates cross hatched capillary features. **FIG. 9***e* illustrates simple horizontal features. while **9***f* shows horizontal features alternating with diagonal features. **FIG. 9***e* shows capillary features that consist essentially of diagonal features.

[0300] As illustrated in **FIG. 9***g* capillary features can be rounded protrusions, preferably in the form of columns of protrusions, more preferably, at least 3 columns of protrusions in which protrusions in a column are not aligned protrusions in adjacent columns. Alternatively, the protrusions could be recesses, in some embodiments recesses with rounded edges.

[0301] **FIG. 9***h* shows trigonal prisms as the protruded capillary features. Again, in alternative embodiments, the protrusions could be recesses.

[0302] For uniform coatings, the capillary features extend substantially over the length of a microchannel or the length desired for a uniform coating. In some embodiments, a microchannel can have capillary features over 50% or less of its length, in some embodiments over 20% or less of its length.

[0303] It may be mentioned that in some preferred embodiments, the cross-sectional SEM view of a uniform layer will show a smooth surface, as is shown for the aluminide layers.

[0304] Electroless Plating

[0305] The use of electroless plating of catalytic metals on reactor walls, both conductive and non-conductive, might also create a uniform coating. Such an electroless plating solution could comprise a water soluble metal salt, a reducing agent such as hydrazine hydrate, possibly a stabilizer such as EDTA to prevent precipitation of the plating metal, possibly an accelerator such as 3,4-dimethoxybenzoic acid or an acid such as acetic acid to adjust the pH for optimum plating. For a microchannel reactor the electroless plating solution is preferably filled (to the desired height) within the channels prior to the initiation of the reaction. The solution could be introduced at room temperature or below and then heated using the embedded microchannels to the requisite plating temperature. In some applications it may be important that the plating process end before the plating solution is drained, particularly if the draining process is long relative to the plating process, to achieve a uniform coating. This can be accomplished by, for example, controlling a plating composition/reaction in which one of the essential reactants is depleted before the draining process begins. Another approach would be to reduce the plating temperature prior to draining. It is contemplated that electroless plating is a good candidate for making uniform coatings in microchannels and it is further contemplated to be used for microchannel coatings; however, this technique has not been proven in microchannels, and the technique would not necessarily result in uniform coatings in microchannels. For example, in addition to the draining issues, the plating liquid should be selected to be stable in microchannels so that particles will not form in solution and drift by gravity. Also, solutions cannot be stirred in microchannels so concentration gradients are likely to occur, and the effect of these gradients isn't known.

[0306] The microchannel wall could be ceramic, metal, alumina-coated aluminide, etc. Preferred metals for the electroless deposition include Cu, Ni, Fe, Co, Au, Ag, Pd, Pt, Sn, Rh, Ir and combinations thereof. It is anticipated that the composition of the plating bath, the rate of plating and plating conditions, eg., temperature, will effect the morphology of the plated coating, i.e., average metal crystalline size. Control of such parameters could yield a metal crystalline size smaller and with a narrower range than expected for