Reynolds number	% Time spent inside the surface features	% Time spent in the main channel
6	11%	89%
24	16%	84%
60	30%	70%
600	37%	63%

[0435] The results show that the residence time of the fluid spent inside the surface features as a fraction of the total residence time increases when the Re number is increased although the overall residence time decreases when Re is increased. This indicates that more effective contact with the active surface is achieved when increasing the flow rates or Re number at least for the range of Re number considered for this work.

[0436] These results are typical for active surface feature patterns that contain more than one angle across the width of any microchannel wall and where substantially similar surface features are repeated for more than 15 features, especially when using a cis orientation on opposing walls. For patterns with only one angle across the width of the microchannel, the fraction of residence time spent within the features is not necessarily improved as the Reynolds number increases.

What is claimed:

1. Microchannel apparatus, comprising:

a microchannel comprising surface features;

at least a segment of the microchannel characterized by a feature entrance length of more than 10;

wherein the segment is at least 1 cm long;

wherein said segment comprises plural similar, repeating surface features; and

wherein the similar, repeating surface features comprise at least 1 angle in each similar surface feature.

2. The microchannel apparatus of claim 1 wherein the microchannel comprises a circumference and wherein the repeating surface features occupy a majority of the circumference.

3. Microchannel apparatus, comprising:

a microchannel defined by at least 3 microchannel walls;

at least a segment of the microchannel characterized by a feature entrance length number of more than 10;

wherein the segment is at least 1 cm long;

wherein said segment comprises plural similar, repeating surface features; and

wherein the similar, repeating surface features comprise at least 1 angle in each similar surface feature.

4. Microchannel apparatus, comprising:

a microchannel comprising a microchannel wall comprising surface features;

wherein the surface features comprise sub-patterning that increases the surface area of the microchannel wall; and further comprising

a catalyst composition disposed on at least of the surface features that comprise sub-patterning.

5. The microchannel apparatus of claim 4 further comprising surface area enhancing metal deposits disposed on the subpatterning.

6. The microchannel apparatus of claim 4 wherein the catalyst composition comprises a catalyst metal disposed on a metal oxide layer.

7. Microchannel apparatus, comprising:

a microchannel comprising a microchannel wall comprising more than 15 similar, repeating surface features; and

wherein the similar, repeating surface features comprise at least 1 angle in each similar surface feature.

8. The microchannel apparatus of claim 7 wherein the microchannel comprises:

two major opposing walls, wherein each of the two, major opposing walls comprise surface features;

a gap between the two, major opposing walls; and further wherein the surface feature depth:channel gap is greater than 0.3.

9. The microchannel apparatus of claim 7 wherein the microchannel wall comprising more than 15 similar, repeating surface features has a length of at least 7 cm.

10. The microchannel apparatus of claim 7 comprising at least 10 microchannels operating in parallel with less than 35% difference in mass flowrate per channel;

wherein each of the at least 10 microchannels comprise more than 15 similar, repeating surface features; and

wherein the similar, repeating surface features comprise at least 1 angle in each similar surface feature.

11. Microchannel apparatus, comprising:

a microchannel comprising a microchannel wall comprising surface features in a staggered herringbone mixer (SHM) configuration wherein the SHM has spaces between angled surface features; and

further comprising fill features situated in the spaces.

12. A method of fluid processing in a microchannel, comprising:

providing microchannel apparatus comprising a microchannel;

wherein the microchannel comprises two opposing microchannel walls and a gap between the two opposing microchannel walls;

wherein at least one of the microchannel walls comprises at least 10 similar surface features in series;

wherein each of the similar surface features comprises at least one angle and a ratio of surface feature depth:channel gap of at least 0.4; and

flowing a fluid through the microchannel at a Re of more than 100.

13. The method of claim 12 wherein the at least 10 similar surface features in series further comprises a catalyst disposed on the surface features.

14. The method of claim 13 comprising methane steam reforming wherein methane flows through the microchannel with a contact time less than 100 ms.