each fin **140** may be straight, tapered or have a serpentine configuration. The fins **140** may be made of any material that provides sufficient strength, dimensional stability and heat transfer characteristics to permit operation for which the process microchannel **110** is intended. These materials include: steel (e.g., stainless steel, carbon steel, and the like); monel; inconel; aluminum; titanium; nickel; platinum; rhodium; copper; chromium; brass; alloys of any of the foregoing metals; polymers (e.g., thermoset resins); ceramics; glass; composites comprising one or more polymers (e.g., thermoset resins) and fiberglass; quartz; silicon; or a combination of two or more thereof. The fin **140** may be made of an alumina forming material such as FeCrAlY, such that when oxidized the skin forms alumina. The alumina skin is particularly suitable for accepting support coatings for catalysts or sorbent materials.

[**0032**] Heat exchanger **170** is positioned adjacent to process microchannel **110** and includes heat exchange channels **172** and **174**. The heat exchange channels **172** and **174** are adapted for heat exchange fluid to flow through the channels in a longitudinal direction parallel to the flow of fluid through the process microchannel **110** as indicated by directional arrows **176**. When the heat exchange fluid flows in the direction indicated in **FIG. 1**, it flows in a direction that is cocurrent with the flow of fluid through the process microchannel **110**. Alternatively, the heat exchange fluid could flow through the heat exchange channels **172** and **174** in a direction opposite to the direction shown in **FIG. 1**, and thus flow countercurrent to the flow of fluid through the process microchannel **110**. Alternatively, the heat exchange channels **172** and **174** could be oriented at a ninety degree angle relative to the process microchannel **110** to provide for the flow of heat exchange fluid in a direction that is cross-current relative to the flow of the fluid through the process microchannel **110**.

[**0033**] Although only a single process channel **110** and two heat exchange channels **172** and **174** are illustrated in **FIG. 1** for use in the apparatus **100**, there is practically no upper limit to the number of process microchannels **110**, and heat exchange channels **172** and **174** that can be used in the apparatus **100**. For example, the apparatus **100** may contain two, four, six, eight, ten, twenty, fifty, one hundred, hundreds, one thousand, thousands, ten thousand, tens of thousands, one hundred thousand, hundreds of thousands, millions, etc., of the process microchannels and heat exchange channels.

[**0034**] The process microchannels **110** may be arranged in parallel, for example, in arrays of planar microchannels. The microchannels may be of the microcomponent sheet architecture variety such as disclosed in U.S. Pat. No. 6,200,536B1, which is incorporated herein by reference. Each of the process microchannels **110** may have a height of up to about 10 mm, and in one embodiment from about 0.05 to about 10 mm, and in one embodiment about 0.05 to about 5 mm, and in one embodiment about 0.05 to about 2 mm, and in one embodiment about 0.05 to about 1.5 mm, and in one embodiment about 0.05 to about 1 mm, and in one embodiment about 0.05 to about 0.5 mm. The width may be of any value, for example, it may range from about 0.1 cm to about 100 cm, and in one embodiment from about 0.1 cm to about 75 cm, and in one embodiment from about 0.1 cm to about 50 cm, and in one embodiment about 0.2 cm to about 25 cm. The length of each of the process microchannels **110** may be of any value, for example, the length may range from about 1 cm to about 500 cm, and in one embodiment 1 cm to about 250 cm, and in one embodiment 1 cm to about 100 cm, and in one embodiment 1 cm to about 50 cm, and in one embodiment about 2 to about 25 cm.

[**0035**] The process microchannels **110** may be made of any material that provides sufficient strength, dimensional stability and heat transfer characteristics to permit operation of the processes for which they are intended. These materials include steel (e.g., stainless steel, carbon steel, and the like); monel; inconel; aluminum, titanium; nickel, platinum; rhodium; copper; chromium; brass; alloys of any of the foregoing metals; polymers (e.g., thermoset resins); ceramics; glass; composites comprising one or more polymers (e.g., thermoset resins) and fiberglass; quartz; silicon; or a combination of two or more thereof.

[**0036**] Each of the heat exchange channels **172** and **174** may have at least one internal dimension of height or width of up to about 10 mm, and in one embodiment about 0.05 to about 10 mm, and in one embodiment about 0.05 to about 5 mm, and in one embodiment from about 0.05 to about 2 mm, and in one embodiment from about 0.5 to about 1 mm. The other internal dimension may range from about 1 mm to about 1 m, and in one embodiment about 1 mm to about 0.5 m, and in one embodiment about 2 mm to about 10 cm. The length of the heat exchange channels may range from about 1 mm to about 1 m, and in one embodiment about 1 cm to about 0.5 m. The separation between each process microchannel **110** and the next adjacent heat exchange channel **172** or **174** may range from about 0.05 mm to about 5 mm, and in one embodiment about 0.2 mm to about 2 mm.

[**0037**] The heat exchanger **170** may be made of any material that provides sufficient strength, dimensional stability and heat transfer characteristics to permit operation for which it is intended. These materials include: steel (e.g., stainless steel, carbon steel, and the like); monel; inconel; aluminum; titanium; nickel; platinum; rhodium; copper; chromium; brass; alloys of any of the foregoing metals; polymers (e.g., thermoset resins); ceramics; glass; composites comprising one or more polymers (e.g., thermoset resins) and fiberglass; quartz; silicon; or a combination of two or more thereof.

[**0038**] The apparatus **100** has appropriate headers, footers, valves, conduit lines, control mechanisms, etc., to control the input and output of process fluids and heat exchange fluids. These are not shown in **FIG. 1**, but can be provided by those skilled in the art.

[**0039**] The apparatus **100**A illustrated in **FIG. 2** is identical to the apparatus **100** illustrated in **FIG. 1** with the exception that the fins **140** are replaced by partial fins **140*a***. The partial fins **140*a*** in **FIG. 2** extend only part way from the fin support **142** to the upper wall **122**. The height of the partial fins **140*a*** may range from about 1% to about 99% of the gap between the fin support **142** and the upper wall **122**, and in one embodiment from about 5% to about 95%, and in one embodiment from about 10% to about 90%, and in one embodiment from about 20% to about 80%. An advantage of using the partial fins **140*a*** is the additional space **145** that is provided in the process microchannel **110** facilitates the use of staged oxygen or air addition which is useful for certain processes such as combustion or selective oxidation reactions. The partial fins **140*a*** permit the oxygen or air to