Microfluidic Device for Blood Oxygenation

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Claims

1. A microfluidic device for blood oxygenation, the device comprising:

a first flow channel configured to carry blood;

a second flow channel configured to carry oxygen;

a gas-permeable membrane made of glass, configured to allow oxygen to permeate from the second flow channel into the first flow channel while preventing blood components from crossing into the second flow channel;

a polymer substrate housing the first and second flow channels; and

mixing elements located within the second flow channel, the mixing elements being configured to facilitate the exposure of blood to the gas-permeable membrane.

2. The microfluidic device of claim 1, wherein the polymer substrate is made from a material selected from the group consisting of polystyrene, polyimide, polycaprolactone, polyglycerol sebacate, polydimethylsiloxane, poly(N-isopropylacrylamide), ceramics, metals, glasses, and carbon or zinc oxide-based nanotubes or nanowires.

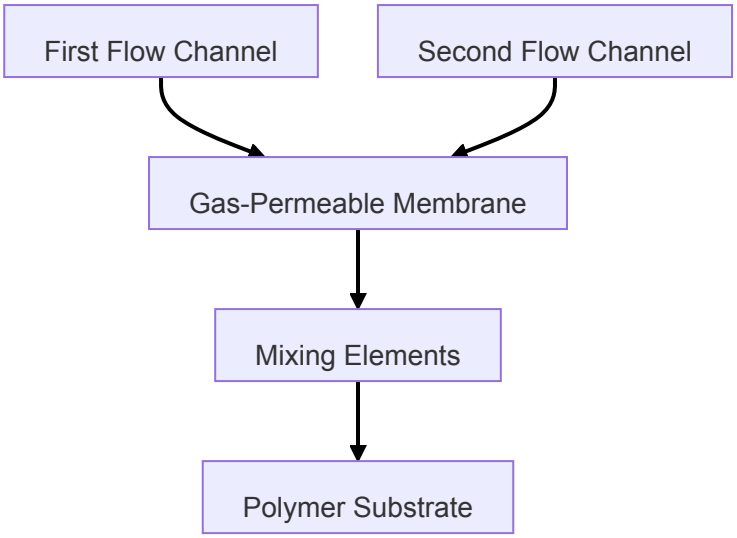
3. The microfluidic device of claim 1 wherein the mixing elements are in the form of ridges, channels, or protrusions.

4. The microfluidic device of claim 1, wherein the mixing elements cover the full length of the second flow channel.

5. The microfluidic device of claim 1, wherein the mixing elements cover a portion of the length of the second flow channel.

6. The microfluidic device of claim 1, wherein multiple types of mixing elements are used in the same device.

7. A method of oxygenating blood using the microfluidic device of claim 1, the method comprising:



introducing partially deoxygenated blood into the first flow channel at a starting end of the device;

directing oxygen through the second flow channel;

allowing the blood to pass the gas-permeable membrane and encounter the mixing elements, thereby oxygenating the blood; and

collecting the oxygen-rich blood at an exit end of the device.

8. The method of claim 7, wherein the device requires a reduced volume of blood, specifically less than 50 ml, to start the oxygenation process compared to prior art devices.

9. The method of claim 7, wherein the device is adapted for applications such as portable oxygenation units and emergency medical kits due to its modular design flexibility.