Microfluidic Redox Flow Battery: Device Layout and Operation

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For roughly a decade now, microfluidic channels have been employed in fuel cells to constrain fuel and oxidant streams to a colaminar flow in order to minimize crossover while eliminating the need for costly membranes. These microfluidic fuel cells reflect much of the behaviour and have evolved many of the same features found in larger traditional fuel cells. In this work a novel device is presented which combines the membraneless microfluidic concept with the rechargeability of vanadium redox flow batteries. By splitting the colaminar streams and harvesting the products for recirculation this low cost proof-of-concept device is capable of serving as a secondary battery. The symmetry of the device is demonstrated which allows for continuous recirculation as well as reversed flow operation. The effects of flow rate and potential are also investigated to determine the operating conditions for highest power output, state of charge or round trip energy efficiency. In discharge operation, the power density of the device is shown to exceed all other microfluidic fuel cells using similar vanadium fuel and oxidant. The round-trip energy efficiency of the device has also been measured to be above 20% for a complete charge-discharge cycle.