

(12) **United States Patent**  
**Perroud et al.**

(10) **Patent No.:** **US 8,815,177 B2**  
(45) **Date of Patent:** **Aug. 26, 2014**

(54) **METHODS AND DEVICES FOR IMMOBILIZATION OF SINGLE PARTICLES IN A VIRTUAL CHANNEL IN A HYDRODYNAMIC TRAP**

(58) **Field of Classification Search**  
USPC ..... 422/68.1, 500, 501, 502, 503, 504;  
436/174, 177, 183  
See application file for complete search history.

(75) Inventors: **Thomas D. Perroud**, San Jose, CA (US); **Kamlesh D. Patel**, Dublin, CA (US)

(56) **References Cited**  
U.S. PATENT DOCUMENTS

(73) Assignee: **Sandia Corporation**, Albuquerque, NM (US)

5,654,238 A 8/1997 Cronin et al.  
6,432,290 B1 8/2002 Harrison et al.  
6,629,820 B2 10/2003 Kornelsen

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 612 days.

(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **12/812,974**

JP 2006-181670 7/2006  
JP 2007-098488 4/2007

(22) PCT Filed: **Jan. 21, 2009**

(Continued)

(86) PCT No.: **PCT/US2009/031515**

OTHER PUBLICATIONS

§ 371 (c)(1),  
(2), (4) Date: **Jul. 15, 2010**

International Search Report for Application No. PCT/US2009/031515 mailed Oct. 28, 2009.

(Continued)

(87) PCT Pub. No.: **WO2009/131722**

*Primary Examiner* — Christopher A Hixon  
(74) *Attorney, Agent, or Firm* — Suzannah K. Sundby

PCT Pub. Date: **Oct. 29, 2009**

(65) **Prior Publication Data**

(57) **ABSTRACT**

US 2011/0028351 A1 Feb. 3, 2011

Disclosed herein are methods of immobilizing a particle which comprise focusing the flow of a sample fluid containing the particle into a virtual channel which flows towards an unoccupied hydrodynamic trap in a microfluidic channel such that the particle flows into the hydrodynamic trap and becomes immobilized therein. Also disclosed are microfluidic devices which comprise at least one microchannel having at least one hydrodynamic trap, at least one focusing fluid inlet, said focusing fluid inlet is upstream of the hydrodynamic trap such that a focusing fluid introduced therein results in a virtual channel of a sample fluid when present which preferentially flows toward the hydrodynamic trap.

**Related U.S. Application Data**

(60) Provisional application No. 61/062,401, filed on Jan. 24, 2008, provisional application No. 61/062,545, filed on Jan. 24, 2008, provisional application No. 61/142,780, filed on Jan. 6, 2009.

(51) **Int. Cl.**  
**G01N 1/40** (2006.01)  
**B01L 3/00** (2006.01)

(52) **U.S. Cl.**  
USPC ..... 422/503; 422/68.1

**8 Claims, 14 Drawing Sheets**

