Supplemental Material: Kinetic Analysis of Trapping Stability

In the article, we stipulated that the amount of work required to release a trapped particle from the slot waveguide is directly related to the amount of force applied to the particle as it leaves the trapping region. This work energy required to release the particle can be thought of as an activation energy barrier to the particles release, an analogy to traditional molecular desporption theories. As a result, it is possible to characterize the rate constant for such a release mechanism using an Arrhenius law for a single particle system:

$$k = A\exp\left(-\frac{W_{trap}}{k_B T}\right) \tag{1}$$

where k is the particle release rate constant, A is the Arrhenius constant, W_{trap} is the work required to release a particle from a slot waveguide, k_b is Boltzmann's constant, and T is the temperature of the system. It has been shown that W_{trap} scales linearly with the optical intensity in a waveguide, so we can write:

$$\bar{k} = k_0 \exp\left(\frac{P}{P_0}\frac{A_0}{A}\right) \tag{2}$$

where k_0 represents a baseline rate constant, P is the optical power coupled in the waveguide, P_0 is a baseline power, A is the cross-sectional area of the slot, and A_0 is a baseline area. The rate at which particles release can be written using a rate law:

$$\frac{dn}{dt} = -kn^x \tag{3}$$

where n is the number of particles trapped and x is a whole number representing the order of the desorption process. The solution of the differential equation would be of the form:

$$F\left(n\right) = k_0 \tau \qquad (4)$$

$$\tau = \exp\left(\frac{P}{P_0}\frac{A_0}{A}\right)t \qquad (5)$$

where *F(n)* is some function of n and τ is an intensity normalized time. The equations above are similar to the Polanyi-Wigner[1] equations for gas desorption from a surface, but written here for the desorption of single particles as opposed to large numbers of gas molecules. This assumption is only valid for the case where the surface coverage of the total number of particles is relatively small such that they don't interfere with one another.

SUPPLEMENTAL MATERIAL: REFERENCES

1. Kolasinski, K. Surface Science: Foundations of Catalysis and Nanoscience (John Wiley & Sons Ltd, West Sussex, England, 2002).
2. Schmidt, B. S., Yang, A. H., Erickson, D. & Lipson, M. Optofluidic trapping and transport on solid core waveguides within a microfluidic device. Opt. Express 15, 14322-14334 (2007).