Movie S1. STM movie recorded at 300 K at 8.6 seconds/frame. Oxygen vacancies are observed to diffuse perpendicular to the bridging oxygen rows. The diffusion proceeds in a correlated manner, i.e., neighboring vacancies undergo diffusion simultaneously from frame to frame.

Movie S2. STM movie recorded at 225 K at 2.3 seconds/frame. Oxygen molecules are observed to diffuse along the Ti rows. When encountering oxygen vacancies, the molecules mediate vacancy diffusion perpendicular to the bridging oxygen rows. Squares denote vacancy positions.