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Charge Transition of Oxygen Vacancies during Resistive Switching in Oxide-based Memristors[1] JIHANG LEE, EMMANOUIL KIOUPAKIS, WEI LU, Univ of Michigan - Ann Arbor — Resistive switching (RS) memristors find applications in non-volatile memory and neuromorphic computing. RS in oxide memristors originates from the redistribution of oxygen vacancies (V_Os) to form conducting filaments of aggregated V_Os. Since the ion migration is facilitated by an applied electric field, V_Os in RS are considered positively charged (V_O^{2+}). We performed density function theory calculations to study the interactions between neutral and charged V_Os in amorphous Ta_2O_5. The cohesive energy between charged V_Os is strongly repulsive at short range, contradicting the experimentally observed high V_O concentration in filaments. On the other hand, neutral V_Os exhibit a short-range attraction that facilitates aggregation, but their charge neutrality precludes interactions with an electric field. We propose a series of charge-transition processes at work during RS that enable V_O drift and aggregation. We experimentally support the proposed model with electrical measurements under visible-light illumination that induce charge transitions of V_Os and enhance the programming and erasing processes. Our results provide microscopic understanding of the RS mechanism and the effect of light on ions/defects migration.

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