In this paper, the air breakdown problem encountered with high-power microwave operation is modeled using a fully coupled nonlinear Newton scheme in the time domain. As a highly nonlinear process, the air breakdown is resulted from the complicated electromagnetic-plasma interactions, which can be described by a coupled system where Maxwell's equations govern the electromagnetic fields, and a simplified plasma fluid equation governs the plasma current. The resulting nonlinear Maxwell's equations are solved by the time-domain finite-element method with a proposed Newton's method, while the simplified plasma fluid equation is solved with another point-wise Newton's method. These two sets of equations are coupled together using a proposed inner-outer iterative scheme to guarantee the convergence and accuracy of the numerical solution. Numerical examples are presented to characterize the nonlinear phenomenon of the breakdown process and the self-sustaining property of the plasma current.