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Modeling Plasma Formation in a Micro-gap at Microwave Frequency ARTHUR BOWMAN, Wayne State University , STEPHEN REMILLARD, Hope College — In the presence of a strong electric field, gas molecules become ionized, forming a plasma. The study of this dielectric breakdown at microwave frequency has important applications in improving the operation of radio frequency (RF) devices, where the high electric fields present in small gaps can easily ionize gases like air. A cone and tuner resonant structure was used to induce breakdown of diatomic Nitrogen in adjustable micro-gaps ranging from 13 to 1,156 μm. The electric field for plasma formation exhibited strong pressure dependence in the larger gap sizes, as predicted by previous theoretical and experimental work. Pressure is proportional to the frequency of collision between electrons and molecules, which increases with pressure when the gap is large, but levels off in the micro-gap region. A separate model of the breakdown electric field based on the characteristic diffusion length of the plasma also fit the data poorly for these smaller gap sizes. This may be explained by a hypothesis that dielectric breakdown at and below the 100 μm gap size occurs outside the gap, an argument that is supported by the observation of very high breakdown threshold electric fields in this region. Optical emissions revealed that vibrational and rotational molecular transitions of the first positive electronic system are suppressed in micro-gaps, indicating that transitions into the molecular ground state do not occur in micro-gap plasmas. Acknowledgements: National Science Foundation under NSF-REU Grant No. PHY/DMR-1004811, the Provost's Office of Hope College, and the Hope College Division of Natural and Applied Sciences.

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