Population Kinetics of a Repetitively-Pulsed Nanosecond Discharge

by

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I would like to dedicate this dissertation to someone else.

ACKNOWLEDGMENTS

Who is this?

Preface

This is a dissertation about something; I really hope it's good.

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DBD dielectric-barrier discharge

APP atmospheric-pressure plasma

CHAPTER 1

Introduction

1.1 Background

1.1.1 History of Atmospheric-Pressure Discharges

Like most physical phenomena, plasmas are typically only described under ideal circumstances. This means that neutral collisions, and subsequently, atmospheric plasmas, are often ignored. Neutral collisions tend to obscure the electromagnetic effects that distinguish a plasma from a gas. However, the history of observation and study of plasmas is indelibly linked to atmospheric plasmas. Lightning and static sparks are the most prevalent plasmas on earth. Indeed, the first artificial plasma was an atmospheric arc, the work of a Russian scientist named Vasilii Petrov.

The work of Petrov was the forerunner to the study of thermal plasmas. In 1802, Volta's recent invention of the voltaic pile provided the first source of constant electrical energy. Using a series of voltaic cells, Petrov was able to draw the first electrical arc between two sticks of carbon. Aside from its blinding light, these arcs were characterized by their significant ionization, and high degree of thermal equilibrium. Gas temperatures could reach thousands of kelvin.

In contrast, later work by Werner von Siemens, led to the discovery of the so-called "silent discharge." In recent years, the terminology has changed and this type of discharge is now referred to as a dielectric-barrier discharge, or DBD. The DBD was significantly different from the thermal arc. Visually, it was much dimmer, and appeared to be composed of many thousands of individual filaments. Additionally, the DBD did not significantly heat the air, unlike the thermal arc. Finally, the DBD was used in the first commercial plasma application: ozone generation and water purification. Notably, both the thermal arc and silent discharge predated the 'official' discover of plasma by Sir William Crookes in 1872.

1.1.2 Repetitively-Pulsed Nanosecond Discharges

For a substantial period of time, these two discharges represented the range of atmospheric-pressure plasmas (APP). The thermal arc, though useful, could not be used on delicate substrates. It had the additional problem of having relatively little control over its chemical kinetics. Meanwhile, the DBD was relegated to ozone production and polymer processing (relatively low-value applications). Though the DBD had attractive thermal properties, little else was known about how it operated, and how to control its properties. As recently as 2007, the National Academies noted that "the full promise of APPs will be known only if they can be understood and managed based on fundamental scientific principles at two extremes–the nanoscopic kinetic level, where selective chemistry occurs, and the global stability level, likened to aerodynamics."

is this true?

1.1.3 Diagnostic Difficulties

Discuss the information that is lacking. No need to be specific, but be clear about challenges

1.1.4 Research Plan

Propose research to fill this gap

1.2 Literature Review

Specific and cited history of PNDS and related measurements.

1.3 Basic Theory

Basic theory of gaseous breakdown.