Popular Science Abstract—Erosion in Spark Plugs

Spark plugs are an important component in gasoline cars— They ignite the gasoline in our engines. Without them, gasoline cars will not be able to run. The burning of gasoline in engines is started by a high voltage applied between the two electrodes of a spark plug, a voltage as high as 1000 AA batteries combined. The result of such a high voltage over a small distance of typically 1 mm in a spark plug is a so-called electrical discharge over the electrode gap. It is safe to say that an electrical discharge is like small-scale lightning, where intense light and a loud voice are created due to a high voltage built in the clouds. And this electrical discharge can damage the electrodes, just like how lightning can strike a tree and destroy it.

While this wear in spark plugs seems minor in passenger cars, it does cause a big problem in heavy-duty trucks and stationary engines, especially those burning natural gas. Compared with gasoline, natural gas engines require a leaner environment for better efficiency and lower emission, which means more air and less fuel is sucked into the engine in one cycle. Such fuel-air mixtures are harder to ignite, so the spark plugs in those engines need to make more effort to get their job done, and thus more damage they must suffer. In the industry this leads to more money spent in both the purchase of the spark plugs and extra service time wasted to replace worn ones. Therefore, it is vital to understand the mechanism of the erosion in order that the lifetime of sparks plugs may be prolonged, to save both money and time.

To achieve this, in this thesis, multiple diagnostic tools were used to observe the emission emitted by the spark. Spectroscopy, the technique that Newton used to demonstrate different colors in sunlight, was used to study the light from the spark to see if there is light at a specific wavelength, indicating the existence of atoms originating from the electrodes in the plasma. A photomultiplier tube, which is a kind of vacuum tube used to detect light signals, was used to investigate the temporal behavior of the spark discharge. Furthermore, high-speed imaging capable of taking over 150,000 images in one second was used to take sequences of photos of the spark.

With the knowledge gained in the work of this thesis, other researchers can develop better models to describe the erosion in spark plugs, and with the models successfully prolong the lifetime of spark plugs by making novel designs or developing new ignition systems.