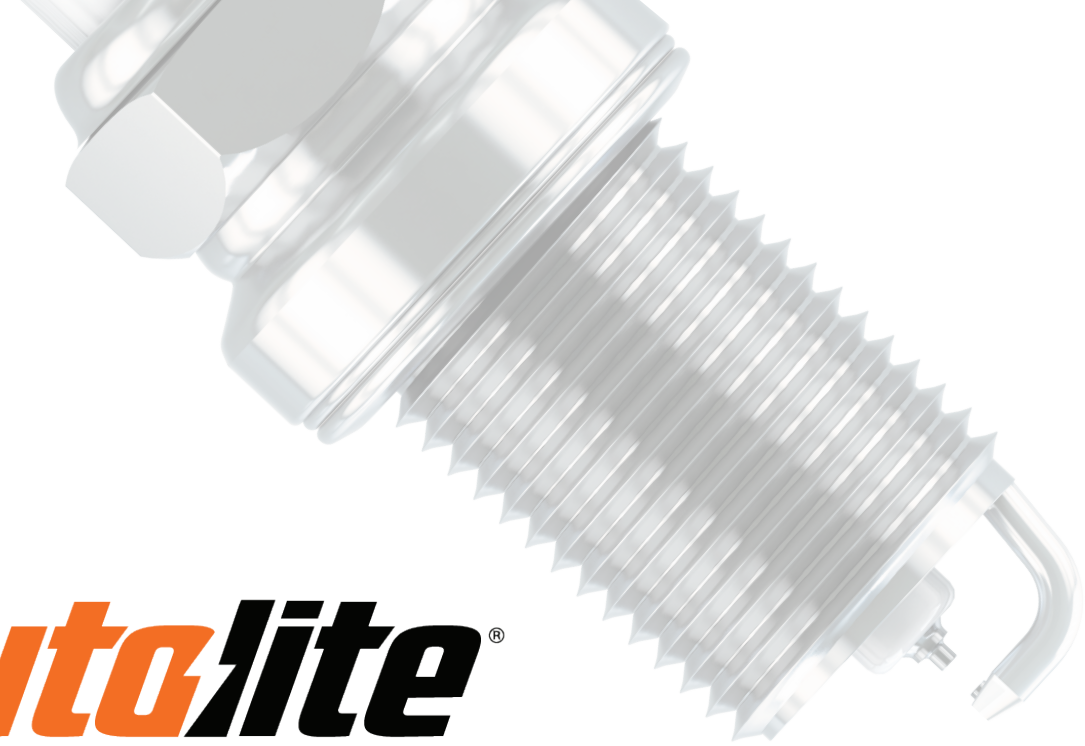

Autolite®

SPARK PLUG METALLURGY EVOLUTION

By: Jay Buckley

Spark Plug Metallurgy Evolution

To best understand how spark plugs work, it's useful to review their technical evolution, including their key role in the development of the electrical ignition systems used by car makers over the last several decades.

From the early 1900s to the 1970s, the ignition system in most cars remained largely unchanged. Featuring a breaker point ignition, these conventional systems utilized an ignition coil to provide the spark while utilizing a distributor as the system's controlling element. The distributor works by switching the primary current on and off, and distributing the current to the proper spark plug each time a spark is needed in the individual cylinders. This system was pretty basic but required a bit of maintenance.

Copper-core plugs work well in these conventional systems because they have a broad heat range. In these systems, the electrical arc—a tiny bolt of lightning—that ignites the air-fuel mixture initiates from the center electrode and jumps the tiny gap to the side electrode. This meant that the sidewire must be designed to run hotter because it's exposed into the combustion path inside the cylinder. At that time, a copper-core plug would typically last 12-25,000 miles.

Then, in the early 1970s, partially due to the Clean Air Act, automakers transitioned from using breaker point assemblies to transistors. Though the ignition still fired the same, the transistors allowed for higher voltage coils and higher output. These electronic ignition systems suddenly generated a much stronger spark and were able to ignite leaner—and cleaner— fuel mixtures.

This change brought about a need to enhance the spark plugs being used. Copper-core plugs were no longer the most acceptable option – automakers wanted plugs that could last longer to go with their newly upgraded and longer lasting ignition systems. This was the advent of the platinum plugs that are most common today. These plugs provided a center wire platinum firing tip for reduced gap erosion, fewer misfires, better performance and more durability. This was just what the automakers needed at that time.

Ditching the distributor

Less than a decade later, automakers started introducing “distributorless” ignition systems. Removing the distributor and the cap meant there was no longer a rotor to replace and no troublesome vacuum or mechanical-advance mechanisms that sometimes caused ignition timing problems that resulted in misfires. In distributorless ignition systems (DIS), the spark fires directly from the coil, and the spark timing is controlled by the Engine Control Unit (ECU). The DIS may have one coil per cylinder; however some popular systems use one ignition coil per two cylinders. In this system, each cylinder is paired with the cylinder opposite it in the firing order. Initially, automakers used copper plugs on these vehicles but found out right away they didn’t work well beyond the initial 15k or 18k miles. The reason copper-core plugs couldn’t, and still shouldn’t, be used is because DIS engines require half the spark plugs to fire unconventionally from the side electrode to the center electrode. Copper core and single platinum spark plugs are not designed to withstand this reverse polarity firing and will suffer premature spark plug gap growth due to center electrode erosion.

This brought on the need, once again, for a higher performing spark plug. So, companies like Autolite started developing Double Platinum spark plugs. In addition to the development of DIS engines, automakers also wanted to start pushing a much longer change interval – 100,000 miles.

Autolite Double Platinum plugs feature platinum on both tips of the electrode so when the DIS fires, the platinum on both tips of the electrode ensures the plug tip does not wear down while maintaining the gap. Iridium-enhanced plugs are also recommended for these types of engines.

Coiling Over the Latest Technology

Finally, the latest engine evolution is called coil-on-plug (COP) – which became more mainstream in the mid to late 1990s. Specifically designed for today's more modern engines, COP systems attach the ignition coils directly to the spark plug, and, therefore, eliminate the need for separate spark plug wires.

COP is rapidly becoming the most widely adapted technology; as such, it will continue to affect the global car park as it is expected to grow to about 80 percent of the new car population by next year. These smaller coils have led to the development of the fine wire iridium plugs we see on the market today as they require less voltage to fire and provide a bigger flame kernel, which adds power, throttle response, efficiency and reduces emissions.

The Premium Paradigm

What's important to note is that premium plugs – either double platinum or iridium-enhanced plugs – now account for more than 80 percent of the car park. And there's a reason for that based on today's engine designs. Putting a fresh set of copper core plugs on applications that require a premium fine wire plug will result in degradation in performance and mileage in a short period of time. Therefore, it's important to use what's specified by the automaker or upgrade to premium plugs, like Autolite XP Xtreme Performance plugs, which many consider the most state-of-the-art plug.

When speaking specifically about XP Xtreme Performance plugs, Autolite engineers actually increased the size of the flame kernel – it's a 21 percent bigger flame compared to that of standard plugs – so it ignites more gas and air mixture inside the cylinders to deliver a better throttle response and improved acceleration. The ignition is also more focused, which provides faster, more complete fuel combustion for better fuel efficiency over the life of the plug. The company has even conducted tests that show how the proprietary platinum ball welding process used for the side electrode provides better overall durability and less electrode wear, which means they last longer than other .6mm and .4mm fine wire designs. Plus, this plug is actually made of both iridium and platinum to help prevent electrode wear. In addition, the use of iridium offers a higher melting temperature, increases corrosion resistance and provides better thermal conductivity. Likewise, the use of platinum provides better protection from oxidation – one of the biggest factors in electrode wear. The result is a long-lasting spark plug created with the metals that provide the ideal resistance for all types of electrode wear.

Where is the technology going?

SMALL! Most engines now have four valves per cylinder, making the combustion chamber very crowded. Add to that, all the Direct Injected engines (majority of 2018 cars) now have a fuel injector right in the combustion chamber. What does that mean for spark plugs? That 12mm diameter spark plugs are becoming very common, with 10mm plugs right behind them. They will get smaller in diameter and longer in length. What does it mean for plug technology? Better materials. It's easy to make thick ceramic insulators with high dielectric strength, much harder when the plug diameter is small, higher quality and high alumina content insulators are required. Same for the business end, precious metals will keep the firing electrode work well with the small diameter.

About the Author

Jay Buckley is the director of technical training at FRAM Filters and Autolite Spark Plugs. A former shop owner, Jay has been an ASE Certified Master Technician for 35 years. His hobbies include autocross, drag racing and a love for anything fast.

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