

2014 – A Bad Year for Vehicle Recalls

In 2014, there were more than 60 million vehicles recalled by auto makers.

In recent years, vehicles have become more electrical than mechanical. They have multiple electronic systems, sensors, and control units overseeing them all. All are linked together with electrical connectors – connectors that are vulnerable to extreme environmental conditions – and where failure is most likely to occur. Many of the recalls last year were related to problems or potential for problems with connectors.

Connector Reliability

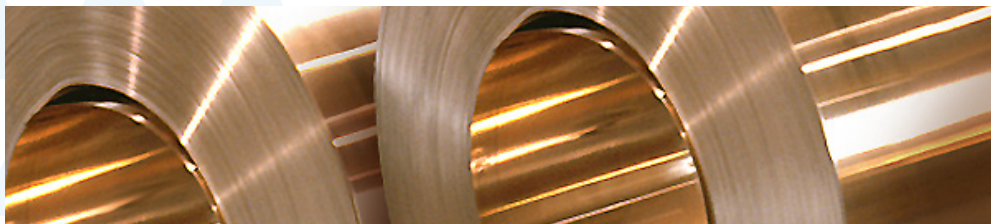
Connectors need to be reliable, passing current and signals without distorting them. If there is distortion, there is potential for a myriad of systems in a vehicle to fail. To prevent signal distortion, the contact resistance must be kept low and stable over the life of the connector, requiring strength, stiffness, formability, conductivity, and stress relaxation resistance in the base metal, along with adequate hardness and lubricity in the plating.

Copper Beryllium Alloys

Copper beryllium has long been the alloy of choice for electrical connectors, providing unparalleled reliability in extreme corrosive and high temperature environments -- like those found under the hood of today's vehicles. In addition to reliability, copper beryllium alloys support many other critical requirements of automotive design, including the need for:

- **Miniaturation** – When contacts are made smaller, the only way to maintain good contact force is to increase the stress in the material. Copper beryllium has the high strength required to withstand this additional stress, and the conductivity required to pass high current through a smaller cross sectional area without overheating or falling victim to thermal runaway. Copper beryllium also has the formability required to form small contacts in tight spaces, without sacrificing strength.

- **Lightweighting** – As vehicles are made smaller and lighter, there will be less mass above the suspension system, meaning that greater shock loads and vibration from the road/tire interface will find its way into the cabin and under the hood, requiring higher strength to resist them. Smaller, lighter wires and cables with smaller connectors can run hotter, given the elevated temperature strength and stress relaxation resistance of copper beryllium.
- **Increasing electrification/electronics density** – With more electrical and electronic devices being included in vehicles, more circuits will be required to connect and power these devices, and each connector will see a greater number of circuits.
- **Greater power** – More power is needed to operate the additional electronic devices included in new vehicles. This requires a combination of higher voltage (potentially increasing the potential for galvanic corrosion and electrical arcing on contact connection and disconnection) and/or higher current (requiring higher conductivity to minimize temperature rise through resistive heating and greater stress relaxation resistance in materials to withstand the higher temperatures generated.)





- **Higher temperatures** – Since, copper beryllium retains a high percentage of its room temperature strength at elevated temperatures, and has excellent resistance to stress relaxation, it will not lose as much force over time as other materials. It can be designed with a lower initial contact force, promoting miniaturization and lowering insertion force.
- **More severe vibration** – Copper beryllium provides the stiffness and contact force required to prevent intermittent contact and minimize fretting corrosion due to vibration.
- **Larger impact & shock loads** – Copper beryllium has the resilience and toughness required to absorb suddenly applied high forces without permanent deformation.
- **Lower insertion force** – Since they retain force so well under extreme conditions, contacts made with copper beryllium can be designed with a lower initial contact force, more closely matched to the end of life contact force. This reduces insertion force per contact, allowing more contacts to be placed into a connector without increasing the required mating force beyond ergonomic limits.
- **Stability** – Copper beryllium's high elevated temperature strength and resistance to stress relaxation means that the contact force changes very little over time. This means that the contact resistance starts low and remains stable over the life of the connector.
- **Reliability** – Copper beryllium has the greatest resistance to loss of contact force over time, even in miniaturized designs carrying high current at elevated temperatures and under heavy vibration. Electronic signals and electrical power will pass through the connector without unacceptable distortion whether the car is one day or 10 years old.
- **Lower cost** – High performance alloys can contribute to lower overall costs with miniaturization. Contacts and connectors can be made smaller, requiring less material as well as less surface area to plate and less plastic to mold around connectors.

