Request 13
ODI understands that the subject vehicles are equipped with engines which contain intake valves manufactured from one of two materials referred to as “Silchrome Lite” and “Silchrome 1”. Describe in detail the differences between these intake valve materials, as well as any other types of materials used in the production of intake valves in the subject engines in the subject vehicles. This includes, but is not limited to, the material properties and specifications of all materials used.

Answer

The intake valves in the subject engines in the subject vehicles are mono-metallic valves. As a result, the material used in the production of these intake valves is either “Silchrome Lite” or “Silchrome 1.”

As stated previously, Silchrome Lite is an industry-recognized valve material with widespread usage in engine valves and is included in the Society of Automotive Engineers (SAE) Engine Poppet Valve Information Report J775_201801 material specification UNS K14072 (reference SAE International Surface Vehicle Information Report, “Engine Poppet Valve Information Report,” SAE Standard J775, Rev. Jan. 2018). UNS K14072 is a martensitic intake valve material containing refractory alloying elements, such as chrome, molybdenum, and vanadium, for improving high temperature strength and moderate corrosion and oxidization resistance.

Silchrome 1 is also an industry-recognized valve material with widespread usage in engine valves and is included in SAE Information Report J775_201801 with UNS/ISO material designation S65007 or X 45 CrSi 9 3. UNS S65007 is a martensitic intake valve material containing high silicon and chromium alloying elements for high temperature corrosion and oxidization resistance.

Martensitic type valves receive a quench and temper heat treatment to obtain the requisite material properties. In the quench step, the valve is heated above the solid solution temperature, also known as austenitizing temperature, then is quenched (rapidly cooled) to a lower temperature, forming martensite. After quenching, the martensitic steel has high hardness, brittleness, and internal residual stresses. To attain the mechanical properties required for the valve application, a tempering step is required to reduce the brittleness and internal residual stresses at a small sacrifice in hardness. Tempering is performed at a temperature below the solution temperature but high enough to allow the diffusion required to transform untempered martensite to tempered martensite. After the intentional heat treatment process, care must be taken in subsequent manufacturing processes to ensure the microstructure is not unintentionally altered.

As described in SAE J775_201801 and shown in the table below, UNS K14072 and UNS S65007 have different solution or austenitizing temperatures. Like in the intentional heat treatment of the valve, if any part of the intake valve exceeds the austenitizing temperature during any manufacturing process, including keeper groove grinding, an austenite transformation will take place on the surface of the valve. When rapidly cooled or quenched by the mass of the part, the surrounding air or machining fluid, this austenite forms hard, brittle untempered martensite at the surface. A phase transformation to untempered martensite also has an associated volume expansion. Since this volume expansion only occurs locally at the surface of the valve, not homogeneously through the cross section, high residual stresses in the surface of the valve result.

Material (Designation)	Austenitizing Temperature
UNS K14072 (Silchrome Lite)	857°-885° C
UNS S65007 (Silchrome 1)	1000°-1050° C

Although the agency has asked on multiple occasions about the differences in these two materials, Ford's answer here and elsewhere demonstrates that both are acceptable materials for use in these applications. The UNS K14072 Silchrome Lite material was used during a three-year production window on the Nano engine and UNS K14072 material from another supplier continues to be used in certain other Ford engines.