Re*active* 1108: Submicron Rhenium powder

1. Rhenium overview

Rhenium is one of Earth's rarest naturally occurring metals but it is of great value for various industries for its unique chemical and physical properties. It is widely known as a base for oil refining catalysts which remains the biggest use. It is also an extremely attractive refractory material, with a melting point of 3180°C second only to tungsten (3420°C). Unlike tungsten, however, its ductile-to-brittle transition well below room temperature gives it high ductility and high resistance to thermal shock and fatigue. These good properties are also found in W-Re alloys. With also a high wear resistance, rhenium is used for conventional electric / electronic contact applications as well as high-tech uses like space propulsion systems.

Unfortunately, this metal has a reputation for being difficult to work and form. The two primary methods for fabricating rhenium are powder metallurgy (PM) and chemical vapour deposition (CVD). CVD is better suited to thin walled small parts, especially with complex shapes. It is also a way of coating metals, ceramics or carbon to improve their surface properties. PM gives better control on the metal microstructure and is well adapted to the preparation of sheet and wire. Traditionally the PM route starts with powder obtained by hydrogen reduction of a salt like Ammonium Perrhenate. The powder is cold pressed to a density of approximately 50%, pre sintered at 1200°C and sintered at 2500°C under vacuum or hydrogen. The sintered part is approximately 80% dense and it has to be repeatedly cold worked to reach nearly full density. It is then made into simple shapes by successive rolling or drawing with intermediate annealing steps.

2. Re*active* 1108: submicron & high sinter ability

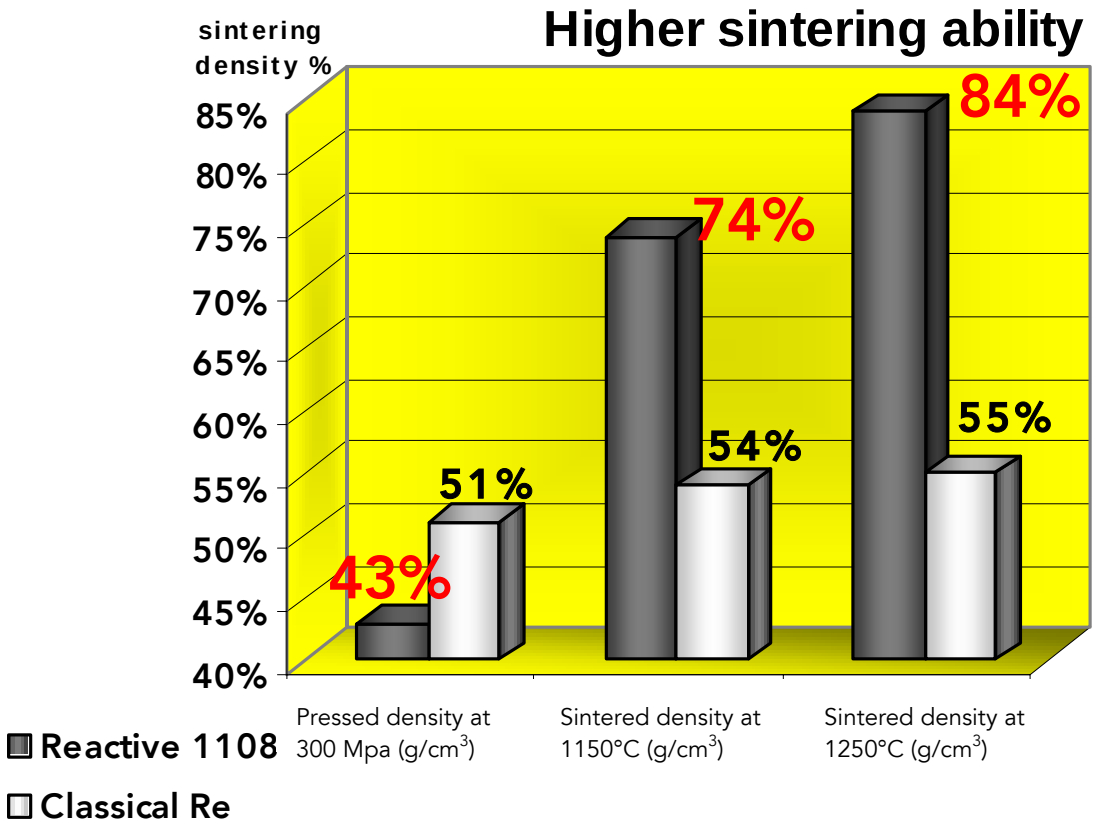
Re*active* 1108

We identified the Re powder structure and size as a limitation of the PM route. Its low sintering activity related to a coarse size lengthens the production of pure rhenium and coarse aggregates mean difficult mixing for the production of W-Re alloys. Eurotungstene developed in the recent years a valuable know-how in the preparation of sub-micron metal with significant improvements in sintering properties when using these finer powders. These techniques were applied to the reduction of rhenium, to give a powder **Re*active* 1108** compared in the following table to a classical Re.

	Reactive 1108	Classical Re
Fisher Size (µm)	0.65	3.5
Laser diffraction size distribution (µm)	d10 : 1.0 d50 : 2.5 d90 : 6.0	d10 : 10 d50 : 30 d90 : 70
Oxygen content (%)	0.9	0.3
BET surface (m^2/g)	2.0	0.2

The new powder has a radically different microstructure as shown by a 10 times increase in BET surface and 5 times decrease in FISHER size. Both are good indicators of high sintering activity. The aggregate size is also reduced by an order of magnitude and this is promising for the mixing properties. This was obtained with an oxygen content of the powder remaining below 1% which is acceptable for most transformation processes.

The sintering activity was measured on cylindrical pellets of Ø 8 mm and thickness 5 to 6 mm, pressed at 300 Mpa. These pellets were sintered at 1150 and 1250°C for 2 hours under hydrogen and the density was measured.



The pressed density is lower with **Re***active* **1108** as a consequence of its fine size but this difference is more than compensated by the sintering activity. The green strength of **Re***active* **1108** is also much better. In the temperature range which is normally used for pre sintering with very little shrinkage, the fine grained rhenium achieved densities in excess of 70 %. With the classical Re this would be obtained only during the high temperature sintering. At 1250°C, the density is high enough to make this high temperature sintering useless.

The characterisation of **Re***active* **1108** has to be completed by industrial testing but at this stage it appears already as an innovative product by its much improved free sintering ability. It has a strong potential to make the forming of bulk metal easier.

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