Press release
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Copper keeps high-speed train developments on track

Reaching speeds in excess of 570 kph, the TGV® has demonstrated its capacity to break its own rail speed record. But how is this performance achieved? The key to speed could well be copper: the red metal is a vital component in catenary systems (10 tonnes of copper per km) and also at the heart of electric traction engines (3 to 4 tonnes per train in the latest-generation rail cars). As the LGV Est (or TGV East - the extension to the French high-speed network) gets ready to open and several high-speed lines are due to be inaugurated in Europe (the final section of Eurostar, the Madrid-Barcelona link, etc.), copper plays its part in driving the TGV®, ICE 3® and other Siemens Velaro® trains.

Speed records: just how fast can we go?

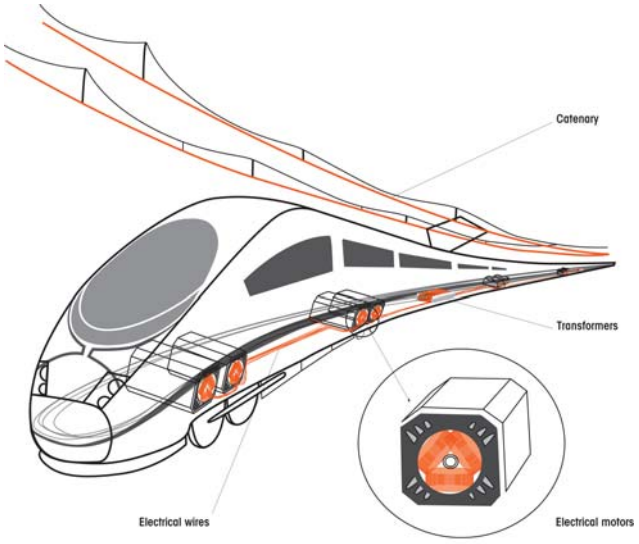
Just as planes are limited by the sound barrier, high-speed trains come up against the "catenary barrier". The catenary is an overhead cable made of pure copper or copper alloy that is suspended horizontally above the track. It supplies the train with electrical power during the journey. The catenary vibrates when the train is moving: according to Roland Lehoucq, Doctor of Physics and Researcher attached to the Astrophysics Department of the French CEA, "*The catenary's upward movement can exceed 30 - 35cm in places*". If the train's speed gets too close to the speed of wave propagation inside the catenary, the catenary will disconnect. "*In practice, the TGV is not allowed to exceed a speed of 70% of the speed of wave propagation throughout the length of the catenary*".

How does copper contribute to pushing back this limit?

The easiest solution to attempt to push back the catenary barrier is to maximise the tension to increase the wave propagation velocity. **Copper plays a dual role here:**

1. Of all the non-precious metals, it is the best electricity conductor. It improves **the catenary's electrical conductivity,** which is a vital function for delivering power to the train;
2. Alloyed with cadmium or magnesium, **it improves the catenary's strength,** thereby enabling greater mechanical strain. In this way the technology can push back the catenary barrier and set new records.

   1 km of catenary uses 10 tonnes of copper.



[picture: electrical cables; electric motors, transformers, catenaries]

The future of high-speed lines: distributed traction motor train sets

The new generation of motor train sets (such as *ICE 3* and Siemens *Velaro*) has abandoned the system of an engine located in the locomotive and opted instead for distributing the traction motors underneath the whole train. Because of the number of electric motors and transformers required, these high-speed train sets use **3 to 4 tonnes of copper**, (compared to 2 to 3 tonnes in conventional TGVs). This technology exploits copper's conductivity properties to generate more speed, reduce energy losses and deliver better performance. Starting in December 2007, ICE 3 will serve the new Madrid-Barcelona line using the name "Velaro". It will cover 650 km in a mere 2 1/2 hours, making it the fastest high-speed rail line in the world.

High-definition images and press file are available on request

About the European Copper Institute:
The *European Copper Institute* (ECI) is a European joint venture between the main copper producers worldwide (represented by the International Copper Association) and the European copper industry. Its mission is to promote the advantages of copper for modern society throughout Europe through its head office in Brussels and its European network of 11 copper information centres.

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