

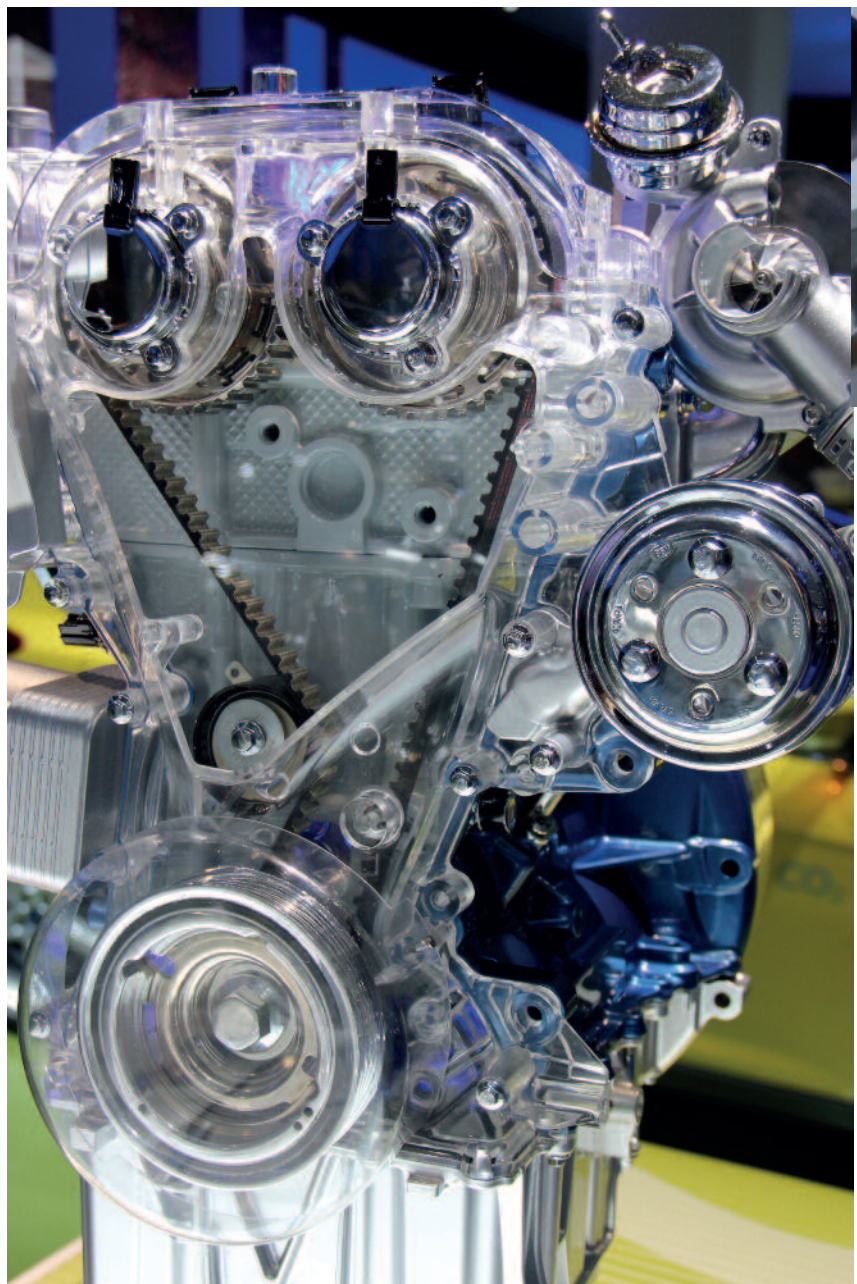
# Timing belts for lower friction: Better, longer, in oil

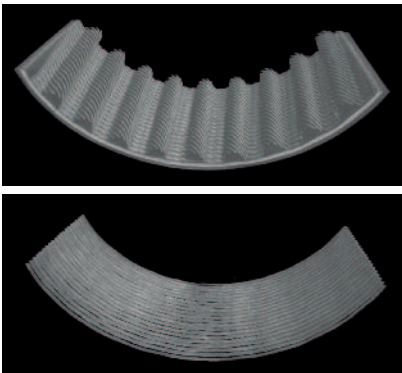
**The days of changing timing belts are over.**

**T**he modern automotive engine has strong requirements for high fuel economy, and low CO<sub>2</sub> emissions. The timing of the combustion process is perhaps taken for granted – but the valves are required to be opened and closed from the rotation of the cam shaft at the right speed, and in phase with the crank shaft. Commonly a steel timing chain, or a glass fibre cord reinforced rubber timing belt is used. For the timing to be as precise as possible, the stiffness needs to be high (for low stretch when load is applied), the creep needs to be low (for low permanent extension under load – a maximum of 0.1% is allowed), and the durability needs to be long (to prevent in-service failures). The stiffness and creep resistance of the belt is provided by a flexible matrix of many thousands of precisely twisted glass fibres. The glass filaments are encapsulated in rubber latex to provide abrasion resistance during dynamic fatigue of the glass.

Until recently, life-of-engine durability was the sole domain of the timing chain. In the previous decade, a change of glass formulation came to the market for the reinforcing cord for belts. The standard E glass could be replaced by the high strength glasses K and U. The tensile strength of a U glass cord is about 1500 MPa, as opposed to 1100 MPa for an E glass cord. The high strength glass cords provided life-of-engine belt durability for gasoline engines.

In 2008, FEV in Aachen took a 1.6 litre gasoline engine and characterised the friction losses and noise of the system with a timing





Ford EcoBoost 1.0 litre gasoline engine, with timing belt running in oil.  
Source: Ford youtube.com video.

chain. The chain and sprockets were removed, and the engine modified to take a timing belt. The engine was re-characterised. Lower friction was measured for the belt system, which would deliver 0.48 to 1.13% higher fuel efficiency and lower CO2 emissions by 1.45 g/km. It was impressive, as this was a lab system, not a highly optimised and developed arrangement. In contrast, a recent paper by Hyundai/Kia and Borg Warner optimised the timing chain for low friction, and were able to improve fuel efficiency by only 0.4%. FEV also found that the noise emitted by the chain or belt meshing with the cam sprocket/pulley was over 15 dB higher at 2000 rpm for the chain than the belt. The overall engine noise was up to 5 dB quieter with the timing belt.

2008 saw the introduction of the first timing belt running in oil, installed on the Ford Lynx 1.8 litre common rail diesel engine. The past

year has seen the launch of the 1.0 litre gasoline Ford EcoBoost engine, also with a timing belt, running in oil, with the durability to last the life of the engine. The reinforcing cord for the belt in oil was made possible by developments in rubber (HNBR polymer for very good oil and temperature resistance) and novel chemical crosslinking systems. The design where the cams are driven by a belt immersed in oil, was pioneered by Ford on its 1.8 l diesel Lynx engine. The Ford powertrain development manager, Andrew Fraser told Automotive Design, "We think it's the best of both worlds: the longevity of a chain, but with the quietness and low friction of a belt!"

The drive to reduce engine friction has been emphasised by other car makers. In their launch of the EA211 gasoline engine the use of the toothed belt for valve actuation was described as a "renaissance... Volkswagen has significantly reduced internal friction in its new generation of engines. Take the example of overhead camshafts (DOHC): the camshafts are not driven by chain here, rather by a single stage, low-friction toothed belt design with a 20 mm wide belt and load-reducing profiled belt wheels. Thanks to its high-end material specification, this toothed belt's service life reliably spans the life of the entire vehicle!" A toothed timing belt is also used on the 2.0 TDI engine with "a positive effect on acoustic comfort"

The development of better materials and high strength reinforcing glass cord provides modern timing belts with the ability to last the life of the engine.

Improved material systems has allowed the introduction of timing belts that can now run inside the engine, in oil, again lasting for the life of the engine.

Current developments are aimed at extending the operating range of the timing belt, to be able to carry higher loads with current durability levels and provide enhanced fuel economy and lower CO2 emissions vs chain.

## Company details



NGF EUROPE Limited is a subsidiary company of the NSG Group, one of the World's leading manufacturers of glass products for building, automotive and information electronics applications. We are at the forefront of the manufacture and marketing of Glass Fibre Cord products.

Our global team is passionate about responding to market needs and this drives our innovative approach to product development, providing worldwide solutions for the automotive industry in the area of sustainability through reduced emissions and improved fuel economy.

From initial concept to final implementation, we work closely with our customers to provide unique added value products.

This approach has helped maintain our position as the market leader and our specialised coating expertise is also being applied to many other fibres such as Carbon and Aramid.

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