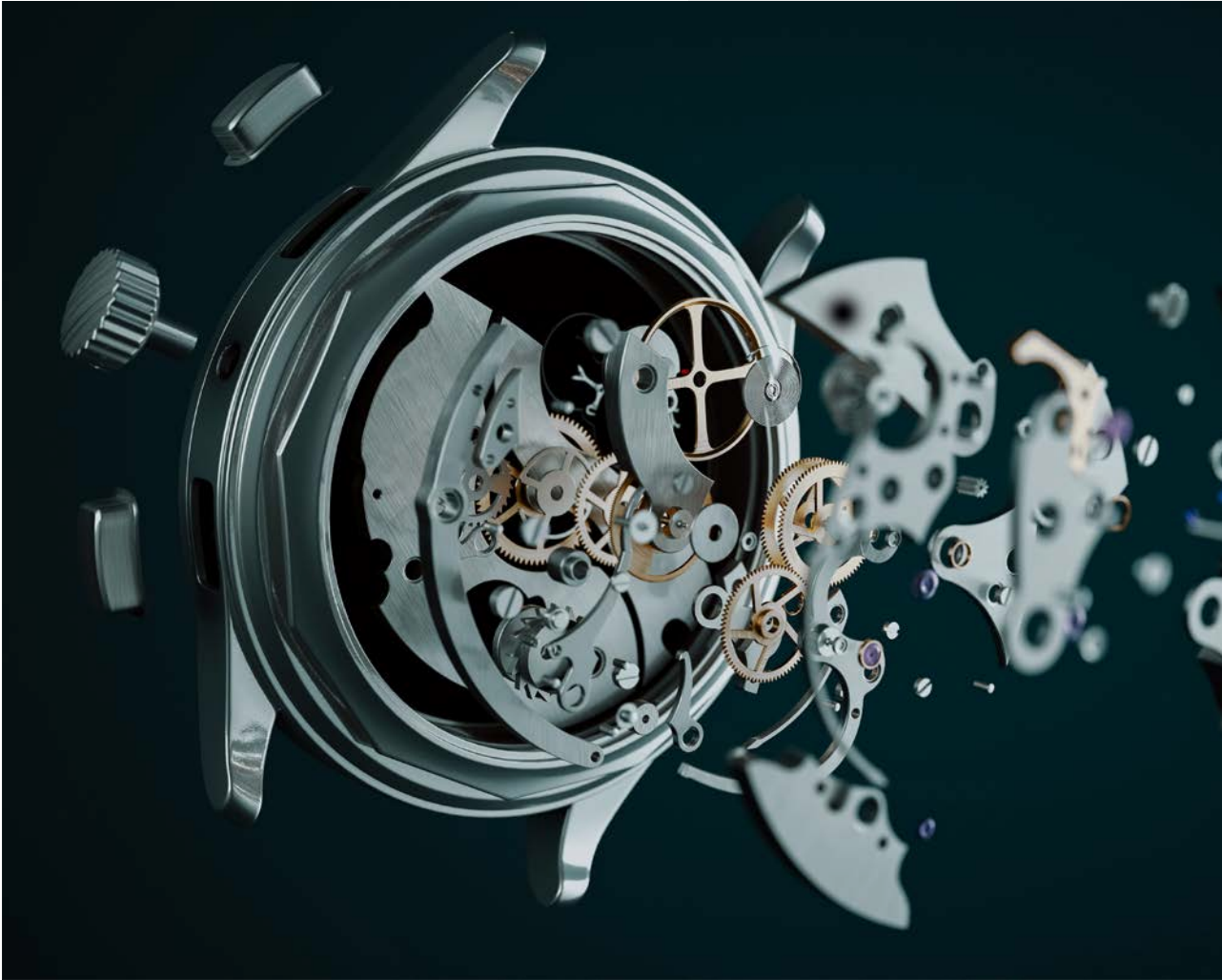




MICRO-MELT[®] LAW 100X

Free-machining, zero-lead steel
for high-precision watch parts

SUMMARY

To luxury watch manufacturers, Micro-Melt LAW 100X is the state-of-the-art, lead-free, free-machining (FM) steel for small, high-precision watch parts. The alloy can be readily machined owing to the perfect metallurgy achieved through powder atomization and fine-tuned processing.

Carpenter Technology and L. Klein SA co-developed and patented Micro-Melt LAW 100X, a sulfide-bearing alloy with 1% carbon, to meet the needs of the watch industry with the comparative advantage of very fine and dispersed sulfides in addition to fine grain size.

Spherical sulfides aid in chip breakage during automatic lathe machining without compromising surface part quality. Micro-Melt LAW 100X provides an alternative to lead-containing grades to meet European environmental regulations and competes with other lead-free free-machining steels, including Sandvik's Finemac. When comparing the microstructure of Finemac, which is cast-wrought, to Micro-Melt LAW 100X, which is atomized, hot and then cold worked, the difference in sulfide size is significant. Finemac has sulfide stringers elongated in the rolling direction ($> 20 \mu\text{m}$), while Micro-Melt LAW 100X has fine spherical sulfides that are less than $3 \mu\text{m}$ in all orientations, even after hot working, owing to the homogeneous mixing from atomization.

Because of the large amount of carbon, **Micro-Melt LAW 100X is delivered fully spheroidized**, which ensures malleability for cold working operations to achieve proper strengthening for Swiss Machine stock. No lamellar carbide is present in the finished microstructure of Micro-Melt LAW 100X.



METALLURGY

Microstructure

Fine grained (ASTM 8-10).

**Fully spheroidized cementite ($\leq 3 \mu\text{m}$)
microstructure in a ferritic matrix.**

- Optimized for further working and machining.

Fine, well dispersed sulfides ($\leq 3 \mu\text{m}$).

- No stringers like cast-wrought FM steel competitors.

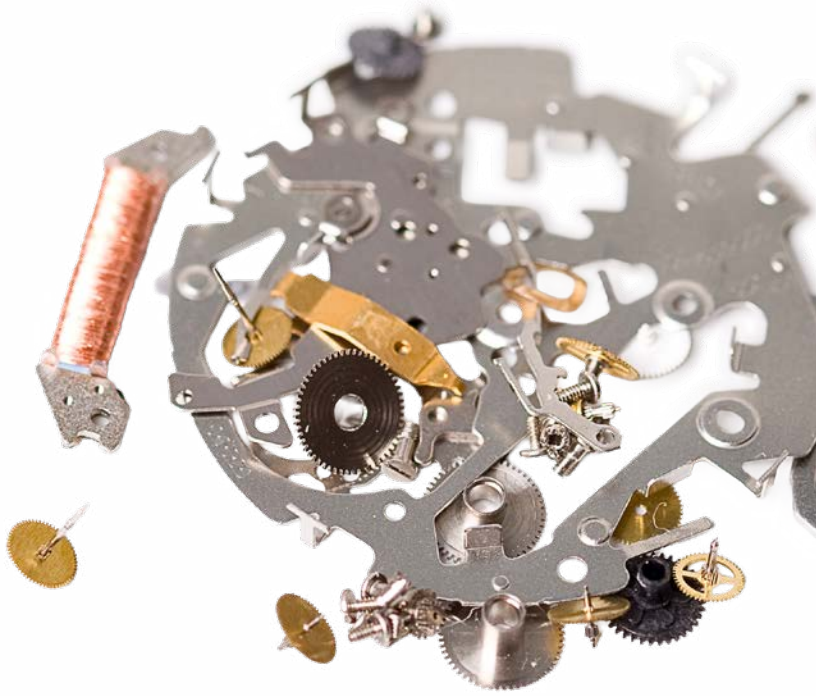
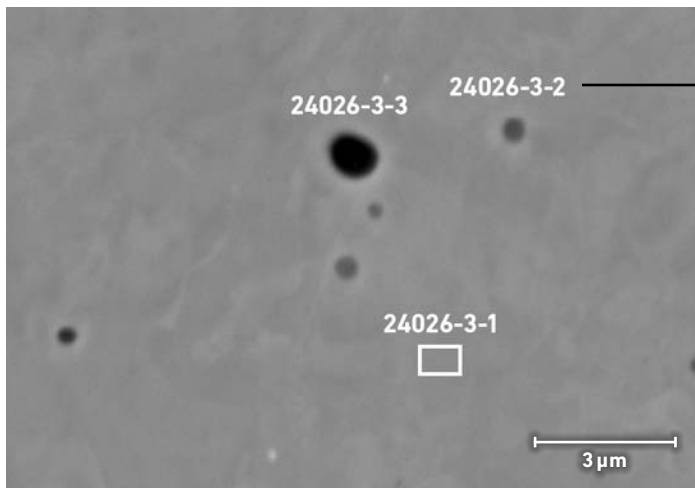
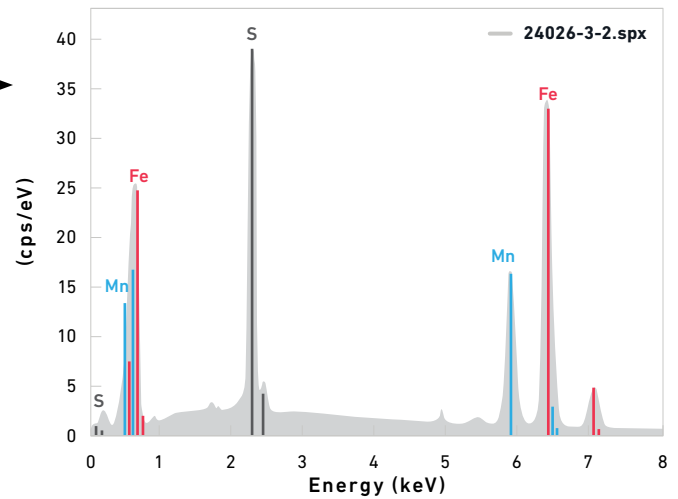


FIGURE 1—SCANNING ELECTRON MICROSCOPY (SEM)

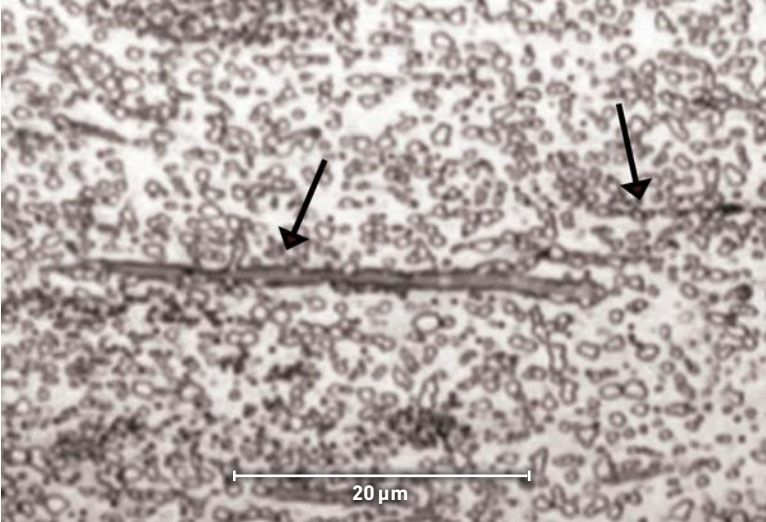
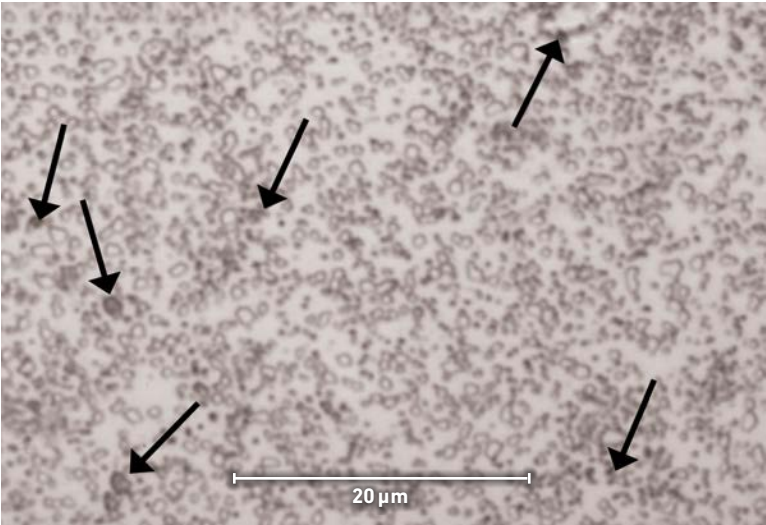


8000x magnification of Micro-Melt LAW 100X
showing very fine, round sulfides.



Relative concentration of elements within one sample area.

FIGURE 2 — COMPARATIVE MICROSTRUCTURE

ALLOY	
Cast-wrought Finemac Sulfide stringers elongated > 20 μm.	
Atomized Micro-Melt LAW 100X Fine spherical sulfides ≤ 3 μm.	

MATERIAL SOLUTION

Performance characteristics

- Lead (Pb)-free
- Excellent machinability and tool durability, ideal for producing small gears and parts
- High wear resistance

Product forms

Micro-Melt LAW 100X is available in smaller bar sizes from L. Klein SA at 1.0 to 4.0 mm with an ultimate tensile strength of ≤ 1100 MPa (160 ksi).

The premium alloy is also available in bar cold worked to desired strength levels:

STRENGTH LEVELS

BAR SIZE		ULTIMATE TENSILE STRENGTH	
MM	IN	MPa	ksi
4–6	0.1575–0.2362	800–950	116.0–137.8
6–7	0.2362–0.2756	750–900	108.8–130.5
7–8	0.2755–0.3149	700–850	101.5–123.3
8–10	0.3149–0.3937	650–800	94.27–116.0
10–15	0.3937–0.5905	600–750	87.0–108.8
> 15	> 0.5905	550–750	79.8–108.8



PATENTS

US8282701B2, US8795584B2

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