Cryogenic treatment technology on steels and cryogenic equipment for high-end manufacturing

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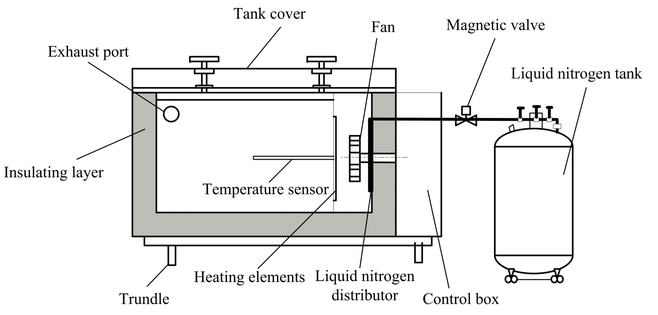
Abstract

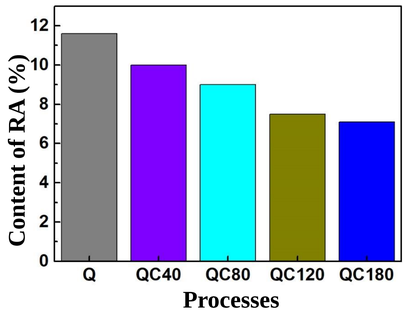
In response to the demand for high-performance materials and components in high-end equipment manufacturing, this paper introduced the research and application results of cryogenic treatment technology in improving the dimensional stability and wear resistance of materials and components. We designed and developed high-end intelligent cryogenic treatment equipment tailored to specific application requirements. A cryogenic treatment equipment with an effective space size of 2500mm(length)×2500mm(width)×2500mm(height) was developed to meet the requirement of dimensional stabilization treatment of large-scale aluminum alloy structural components. The temperature control range of this equipment was -190 ℃ -+180 ℃. A cryogenic treatment equipment with an effective space size of 5000mm(length) ×5000mm(width)×1000mm(height) and a temperature control range of -150 ℃ -+100 ℃ was developed for the cryogenic treatment of large wind power bearings. We also developed a super large cryogenic treatment equipment with the effective size of 11000mm(length)×5800mm(width)×4500mm(height).

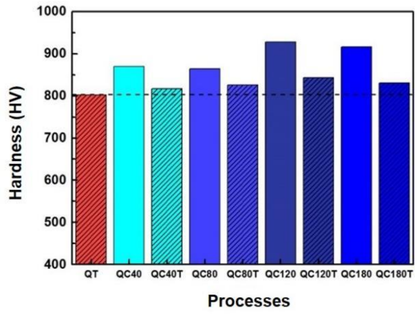
Cryogenic treatment

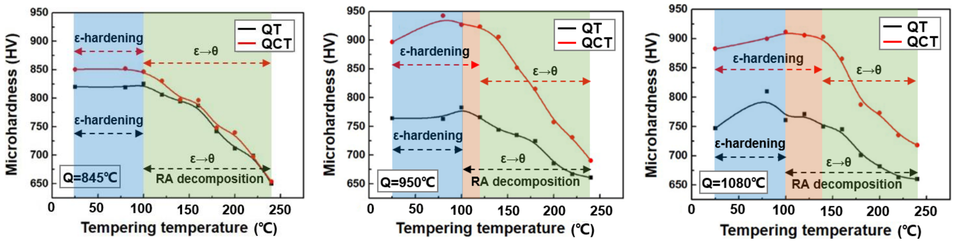
Cryogenic treatment is the process of subjecting materials at ultra-low temperature (generally below -100 ℃) for certain time to optimize the service performance through changing the microstructure and stress state irreversibly. Cryogenic treatment has been proved to enhance the mechanical properties, wear resistance, dimensional stability, corrosion resistance for ferrous steels and nonferrous alloys.



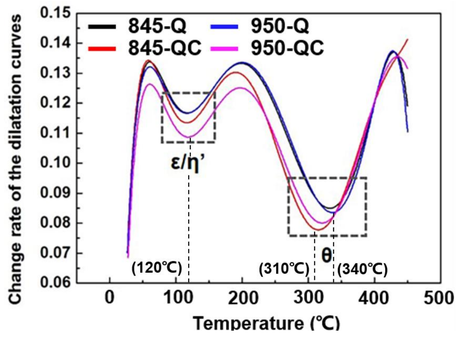
Cryogenic treatment on steels

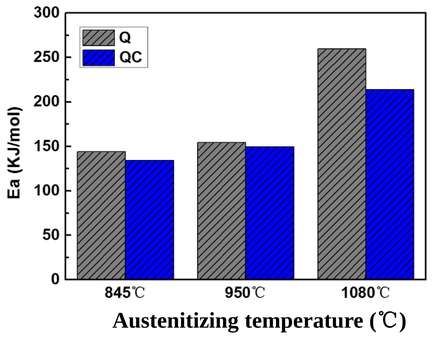


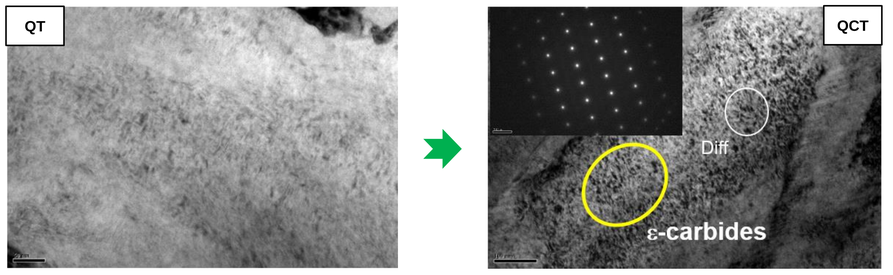




- Cryogenic treatment reduces the content of residual austenite in quenched bearing steel. RA content decreases with the decrease of treating temperature
- The addition of cryogenic treatment increases the hardness compared with the traditional quenching-tempering treatment. Hardness increases with the decrease of treating temperature
- Cryogenic treatment extends the temperature range of age-hardening, which becomes much more obvious under higher austenitizing temperature





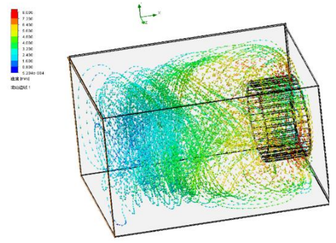


- Cryogenic treatment intensifies the shrinkage of sample, indicating an enhanced precipitation of transition carbides and consequently promoting the precipitation of stable carbides after tempering.
- Activation energy of retained austenite decomposition implies a degraded thermal stability of retained austenite after cryogenic treatment.

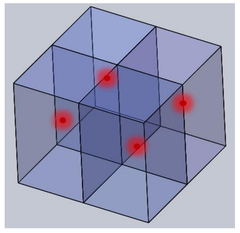
Cryogenic equipment

- 200×300×500 mm^3
- Applied for experimental samples and small-sized components

- 900×600×600 mm^3
- Applied for shafts, bearings, and other medium-sized structural parts



- Flow field optimization



- Coordination temperature control