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STUDY OF CEMENTITE MORPHOLOGY DURING SPHEROIDISATION BY ASR PROCESS

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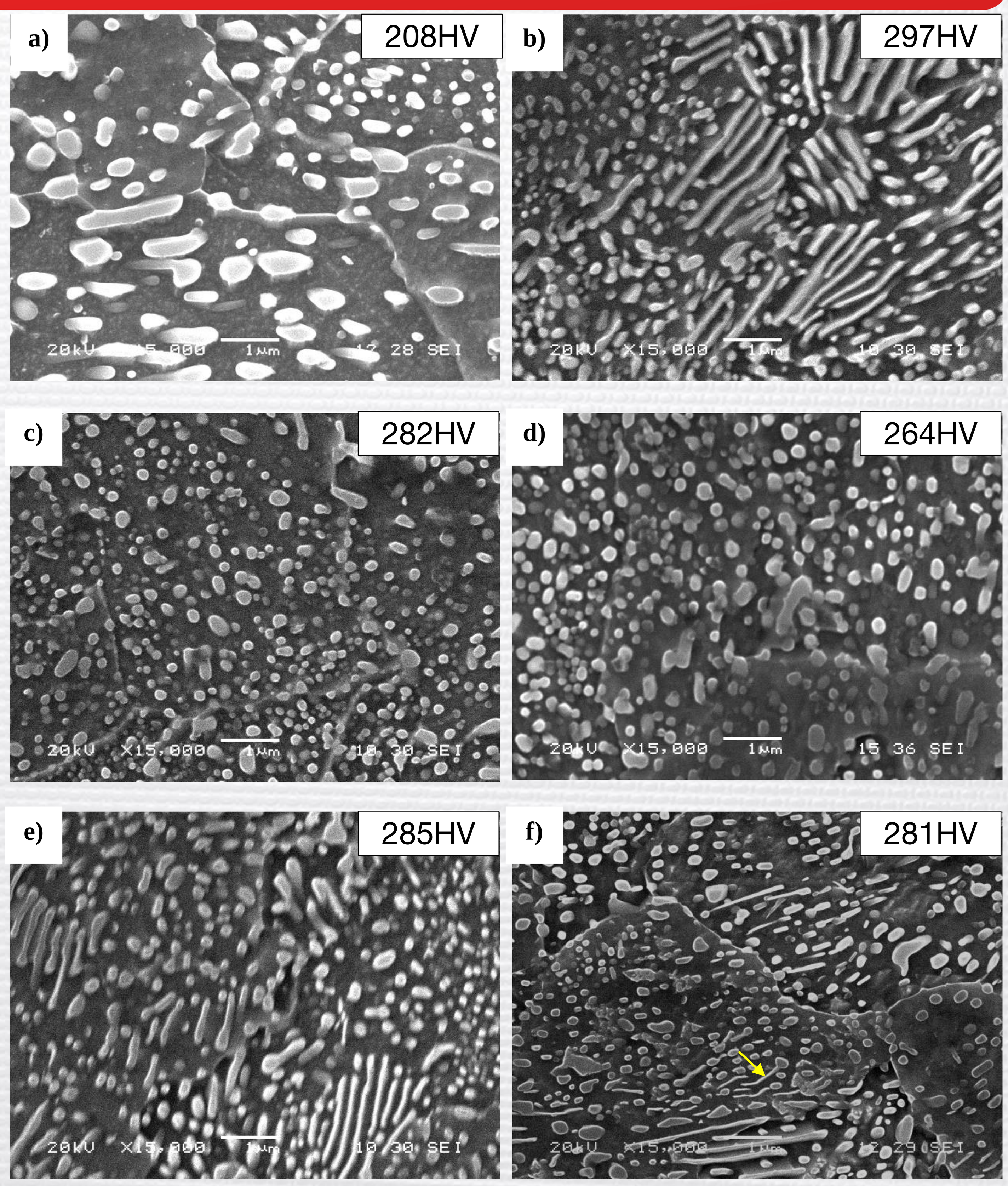
ABSTRACT

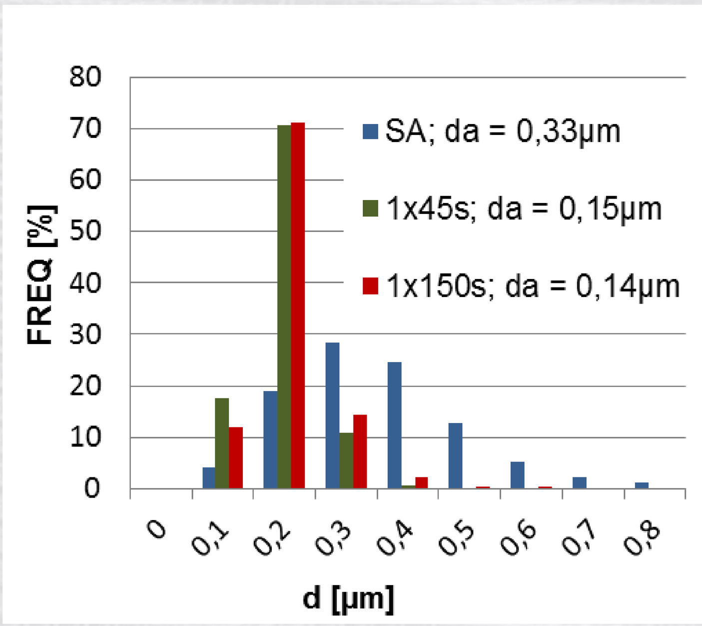
Carbide spheroidisation in steels is morphology change driven by cementite/matrix interphase area minimization. It is intentionally induced during soft annealing of steel semi-products. Accelerated carbide spheroidisation (ASR) process was developed to facilitate this process.
Cementite morphology evolution during ASR of bearing steel 100CrMnSi6-4 is presented in this article. Initial lamellar pearlitic structure was spheroidised by repeated austenitization and divorced pearlitic transformation. Cementite morphology was studied in different stages of the process. It was revealed by deep etching with carbide separation and conventional metallographic section observation.

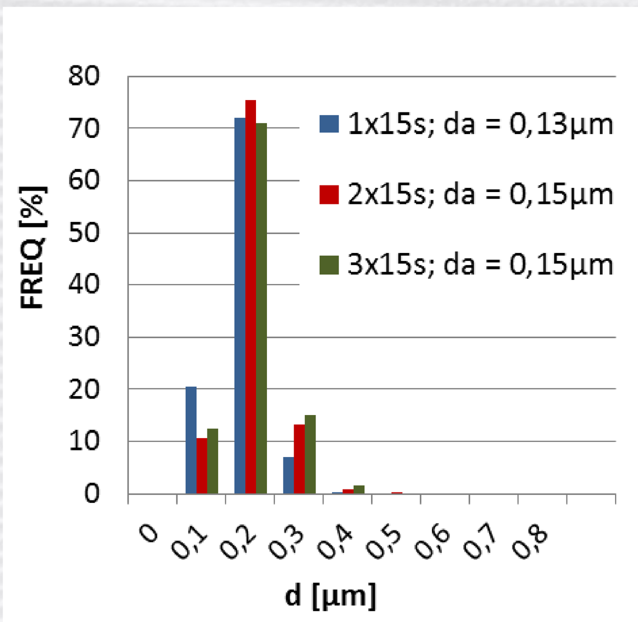
Detailed study of cementite morphology is necessary for spheroidisation mechanism understanding. ASR is quick process in comparison with spheroidisation during long soft annealing and uses non-equilibrium states to achieve rapid morphological change. Thus, it is sensitive to parameters of used temperature regime. The ASR principle understanding will ease significantly ASR parameters tailoring for different materials and semi-product shapes and dimensions.

CEMENTITE MORPHOLOGY



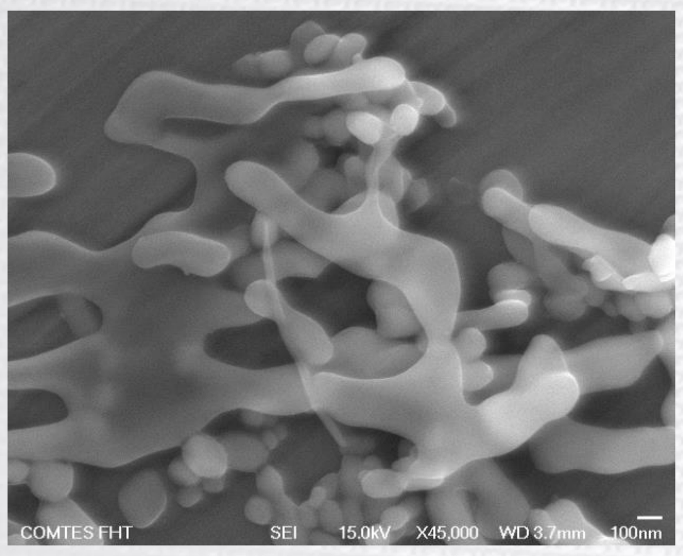
Microstructures after the regimes a) SA, b) 1×15s, c) 2×15s, d) 3×15s, e) 1×45s, f) 1×150s. Arrow marks new cementite lamellae.





Size distribution of globular cementite particles after heat treatment. Particles with aspect ratio (AR) < 2 were included.

Diameter „d“ is equivalent diameter of circle with the same area as area of the particle section; „da“ is average equivalent diameter of all measured particles with AR < 2.



Cementite particles separated from sample 1×45s by deep etching.

MATERIALS AND METHODS

Experimental steel had pearlitic structure with hardness 351HV. The steel underwent thermal treatment in inductor and for comparison also soft annealing in furnace. All regimes are listed in table below.

Regime	Description
SA	Heating to 790°C/11hrs hold/cooling in furnace
1×15s	Heating to 780 °C/15s hold/air cooling
2×15s	Heating to 780 °C/15s hold/air cooling to 680 °C/heating to 780 °C/15s hold/ air cooling
3×15s	Three times heating to 780°C/15s hold/intermediate air cooling to 680°C, final cooling on air
1×45s	Heating to 780 °C/45s hold/air cooling
1×150s	Heating to 780 °C/150s hold/air cooling

CONCLUSION

Mechanism of ASR lies in fragmentation of cementitic lamellae into rods and subsequently into globules. This process is most intensive during austenitization and forms globules with quite narrow size distribution. The size of globules is not determined by coarsening at annealing temperature like in case of soft annealing. It is determined by thickness and distribution of initial cementitic lamellae. Resulting structure after ASR is more homogeneous in term of cementite globules size and distribution in comparison with structure after soft annealing.
Size of the globules after ASR is significantly smaller. It causes dispersion strengthening responsible for the higher hardness compared to soft annealing. Finer structure promises also faster cementite dissolution during hardening process, which is now subject of further research

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