



Characterization of dislocation loops in ferritic martensitic steels irradiated within the SPICE programme

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The SPICE programme

Specimens of EUROFER97 prepared of impact tests have been irradiated up to an average dose of 16.3 dpa at irradiation temperatures of **250°C, 300°C, 350°C, 400°C and 450 °C**. The neutron irradiation was performed in the HFR (High Flux Reactor, Petten, Netherlands). Neutron flux was $3.99 \times 10^{18} \text{ m}^{-2}\text{s}^{-1}$ ($E > 0.1 \text{ MeV}$). The TEM specimens were prepared and analyzed in the FML (Fusion Materials Laboratory) of the Hot Cell facility of KIT Campus North Karlsruhe.

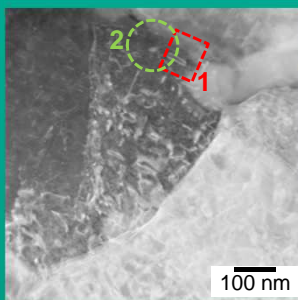
EUROFER97

Heat 83697

Cr	W	Mn	V	Ta	C
9.81	1.08	0.48	0.2	0.14	0.12
O	P	S	N	Fe	
0.0008	0.005	0.004	0.02	bal.	

350°C / 16 dpa Irradiation

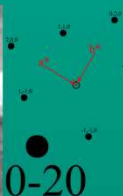
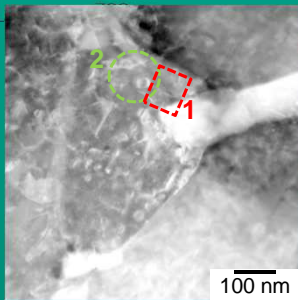
Loop formation and determination of Burgers vector



Weak beam dark-field imaging is used to determine the type of Burgers vector

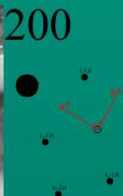
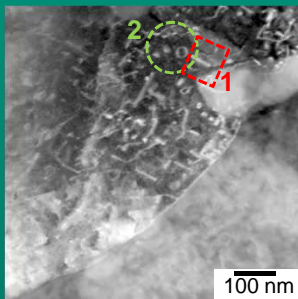
g / b	$\frac{1}{2} [111]$	$\frac{1}{2} [\bar{1}\bar{1}\bar{1}]$	$\frac{1}{2} [\bar{1}11]$	$\frac{1}{2} [1\bar{1}\bar{1}]$	[100]	[010]	[001]
$\bar{1}10$	0	1	1	0	1	1	0
110	1	0	0	1	1	1	0
020	1	1	1	1	0	2	0
200	1	1	1	1	2	2	0

[g*b] values for a [001] beam direction [1]



Loop No. 1

- Invisible in [020] images
- Visible in [0-20] and [110] images
- The resulting Burgers vector b is of [100]-type.

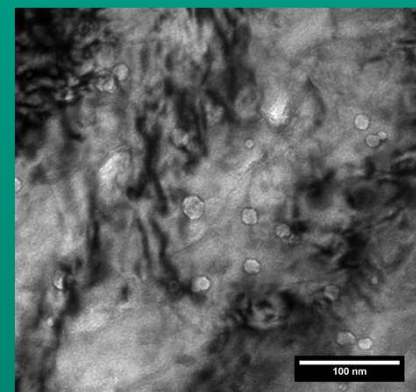
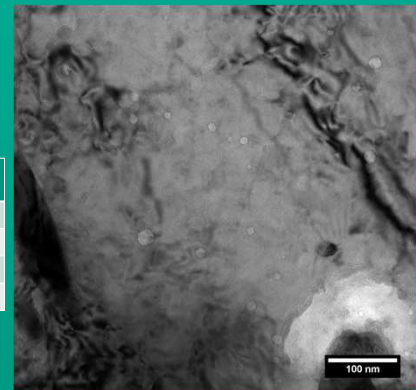


Loop No. 2

- Invisible in [110] images
- Visible in [200] images
- The resulting Burgers vector b is of [111]-type.

350°C / 16 dpa Irradiation

Cavity formation



- Faceted Cavities were detected only in the specimen irradiated at 350° C
- The size of the cavities varies from 10 nm to 35 nm

Conclusions:

- The authors identified loops with a Burgers vector b of $\frac{1}{2} [111]$ and [100] type in the 350°C irradiated material by using weak beam dark-field imaging in the TEM
- Typical loop size was measured to be in the range of 10 nm ([111]-type) and 50 ± 15 nm ([100]-type)
- Cavities with a density of $1.2 \times 10^{20} \text{ m}^{-3}$ were observed in the sample after 350°C irradiation

[1] F. Luo et al. / Journal of Nuclear Materials 455 (2014) 339-342