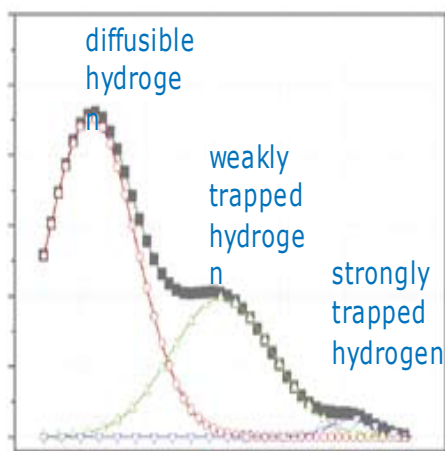




原理图解



什么是扩散氢?

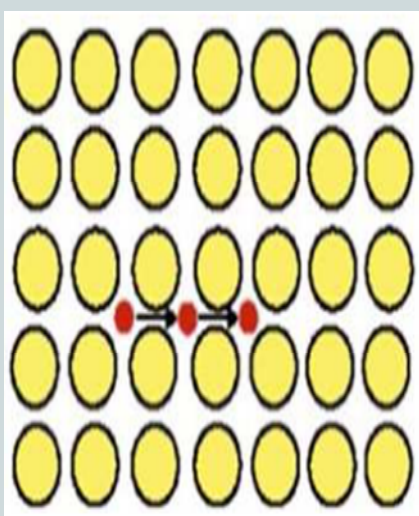


金属中氢的存在形式:

- 扩散氢
存在于晶格中, 可自由移动
- 残余氢
被捕获的分子氢, 不可自由移动
- 键合氢
形成稳定化学键的氢化合物



扩散氢的危害



扩散氢特点

- 氢是元素周期表中最小的原子
- 氢原子很容易进入金属并在晶格中移动
- 氢原子可以在一些晶格缺陷中重新化合为氢气分子
- 这种现象导致氢脆



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钢铁中的扩散氢

The diagram illustrates the diffusion of hydrogen in a steel lattice. On the left, a cross-section of the lattice is shown with a color gradient from dark red to light pink, representing the electron gas. A legend on the right lists the atomic radii and ionic radii of Fe, Fe³⁺, Li, Li⁺, H, and H⁺ in pm. The lattice distance is indicated as 287 pm. On the right, a 3D diagram of a body-centered cubic (bcc) lattice is shown with a coordinate system (x, y, z). The legend below the 3D diagram identifies the symbols: a white circle for 'Gitterplätze' (lattice sites) and a black dot for 'Oktaeder- und Tetraederlücken' (octahedral and tetrahedral interstices).

Symbol	Value (pm)
Fe	124
Fe ³⁺	68
Li	155
Li ⁺	89
H	37
H ⁺	0.00087

electron gas

lattice distance 287 pm

ThyssenKrupp Steel Europe

ThyssenKrupp

bcc lattice

○ Gitterplätze
● Oktaeder- und Tetraederlücken

Bruker Elemental



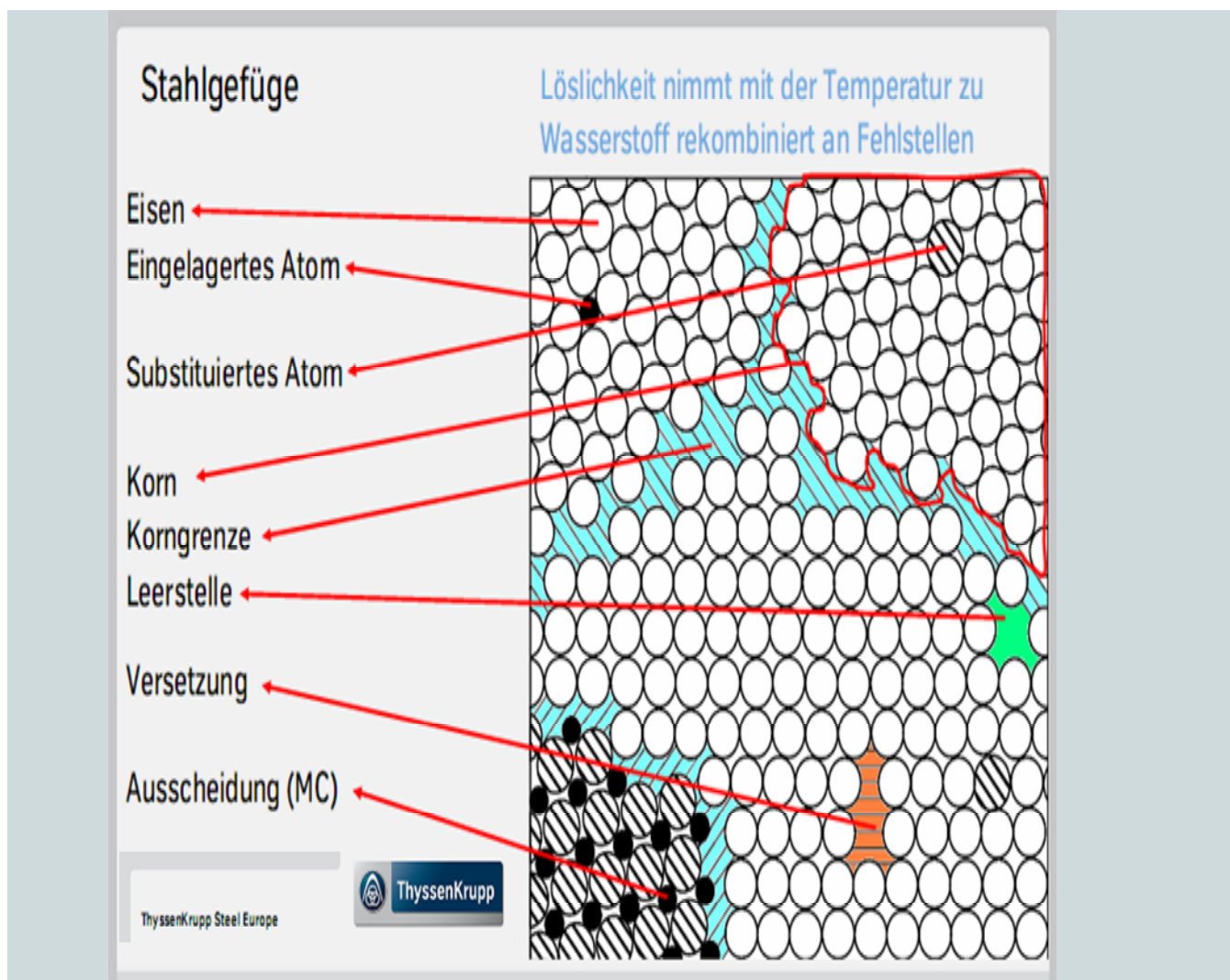
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钢铁中的扩散氢



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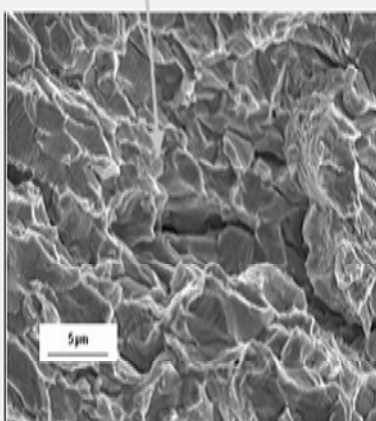
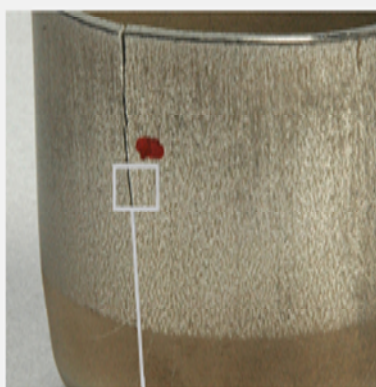
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钢铁中的扩散氢

高强度钢中由扩散氢引起的延迟裂缝



- Hydrogen induced delayed crack formation/fracture
- Intercrystalline fracture

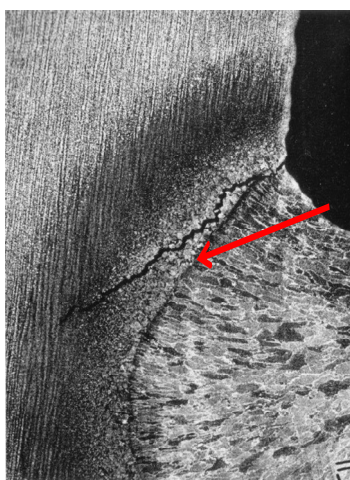
ThyssenKrupp Steel Europe



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焊缝中的扩散氢



焊缝中由于扩散氢的存在而导致的延迟裂缝,

扩散氢的主要来源

- 焊接填充填充材料
- 周围大气中的水湿气
- 添加物
- 冷凝在焊接部位的水





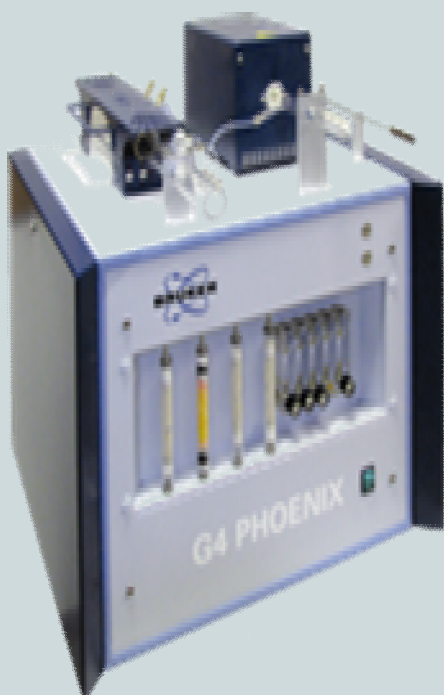
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G4 PHOENIX DH 扩散氢分析仪



分析原理:

- 热萃取, 惰性气体载气方法, 热导检测器
- 将被测样品在样品管中加热
- 加热炉:
 - 红外炉, 最高 900°C
 - 管式炉, 最高 1100°C
- 氢气被释放出通过载气进入检测器检测
- 通过积分面积计算扩散氢含量

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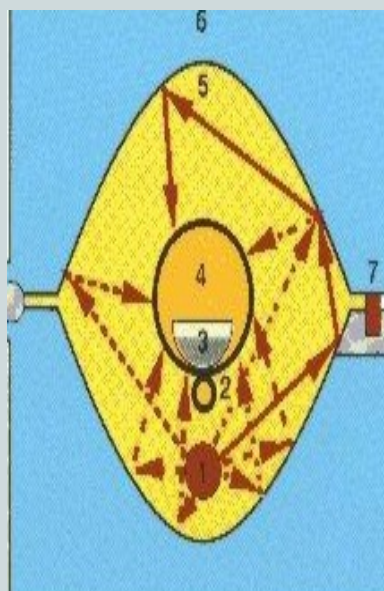
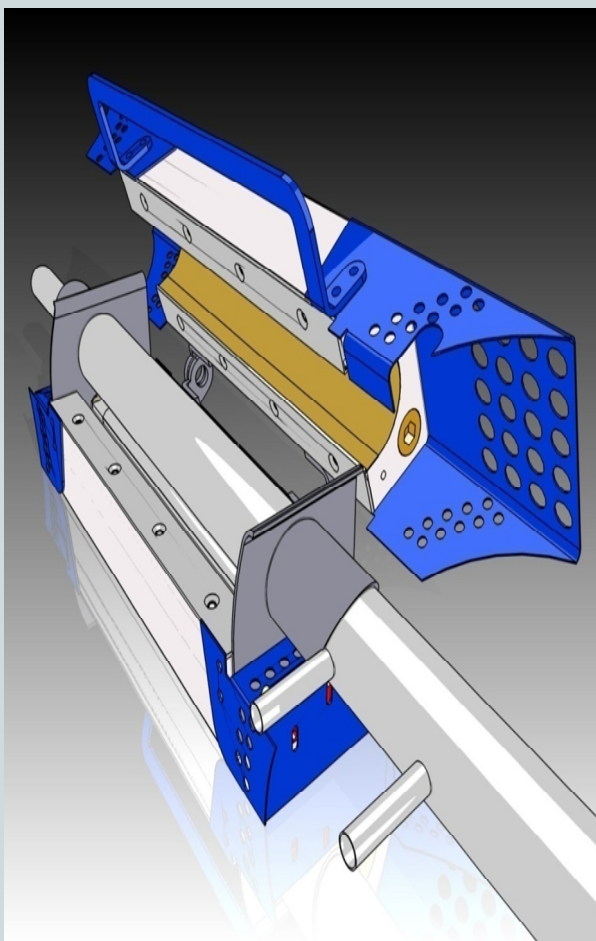
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G4 PHOENIX DH

红外炉



- | | |
|---------------------|------------------------|
| 1 Infrared Radiator | 5 Elliptical Reflector |
| 2 Thermocouple | 6 Furnace Body |
| 3 Sample | 7 Safety Switch |
| 4 Quartz Tube | |

Bruker Elemental



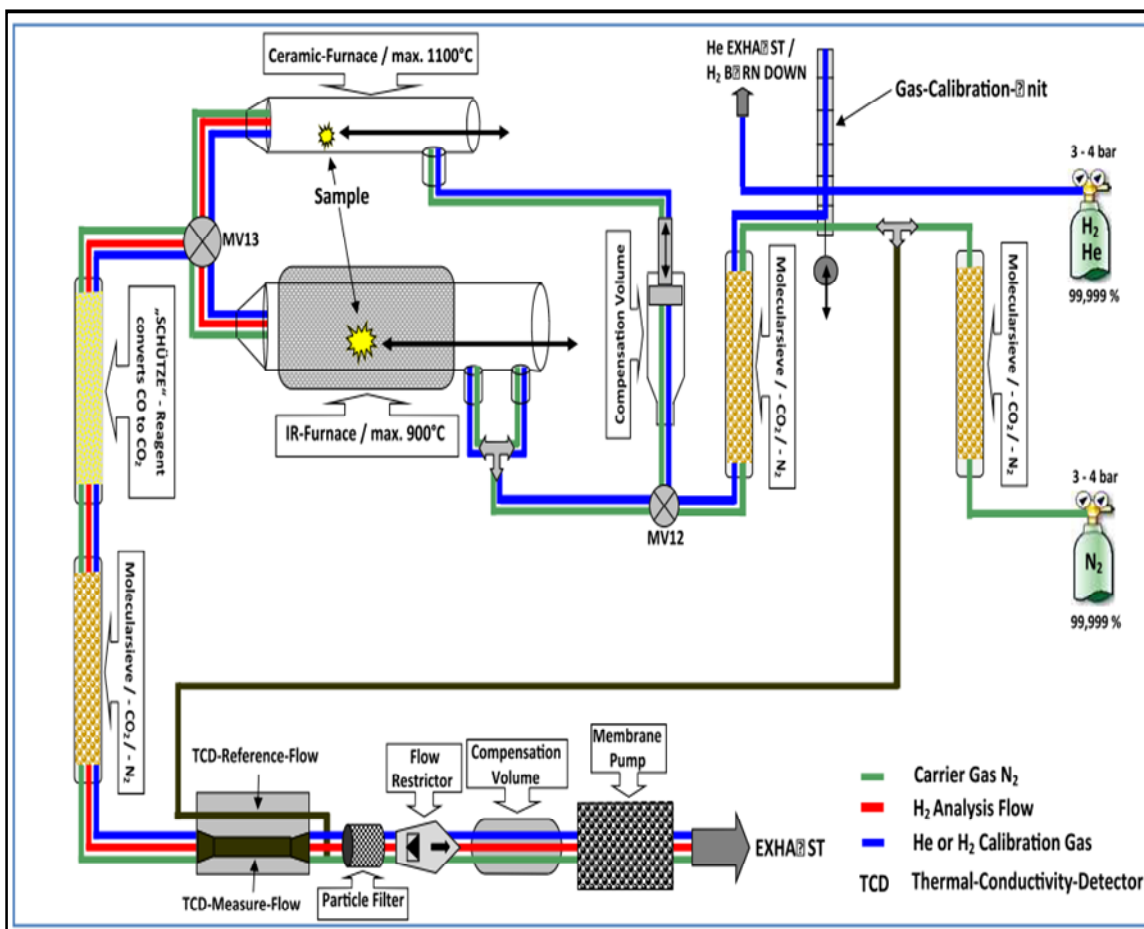
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G4 PHOENIX DH Gas flow



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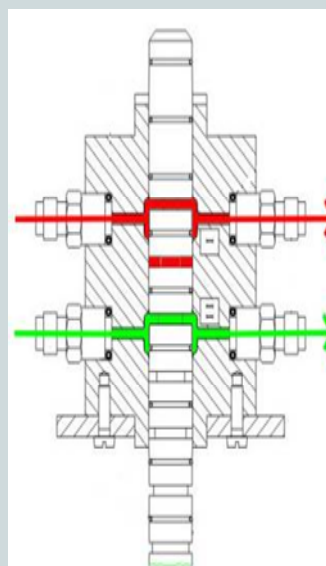
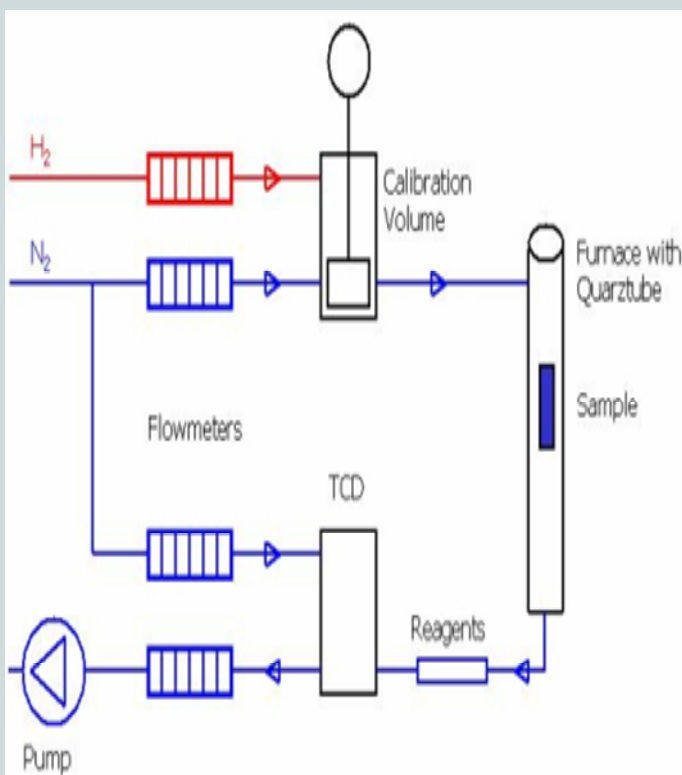
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G4 PHOENIX DH

气标校准(10种体积)



Volume 1:	0.03488	Volume 6:	0.42338
Volume 2:	0.07997	Volume 7:	0.50427
Volume 3:	0.16358	Volume 8:	0.59202
Volume 4:	0.24364	Volume 9:	0.66760
Volume 5:	0.32641	Volume 10:	0.75912

Volumes in ml

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G4 PHOENIX DH

分析报告——符合ISO3690及AWS A4.3

Weight	Sample code	Comment	Oxygen	Nitrogen	Hydrogen	Investigating Laboratory:
2222	pLUTONIUM 2	TEST 2				

Investigator's name: _____

Current: 2222 Previous: 0 Difference: 0

Buttons: Cancel, OK, Apply, Copy, Paste

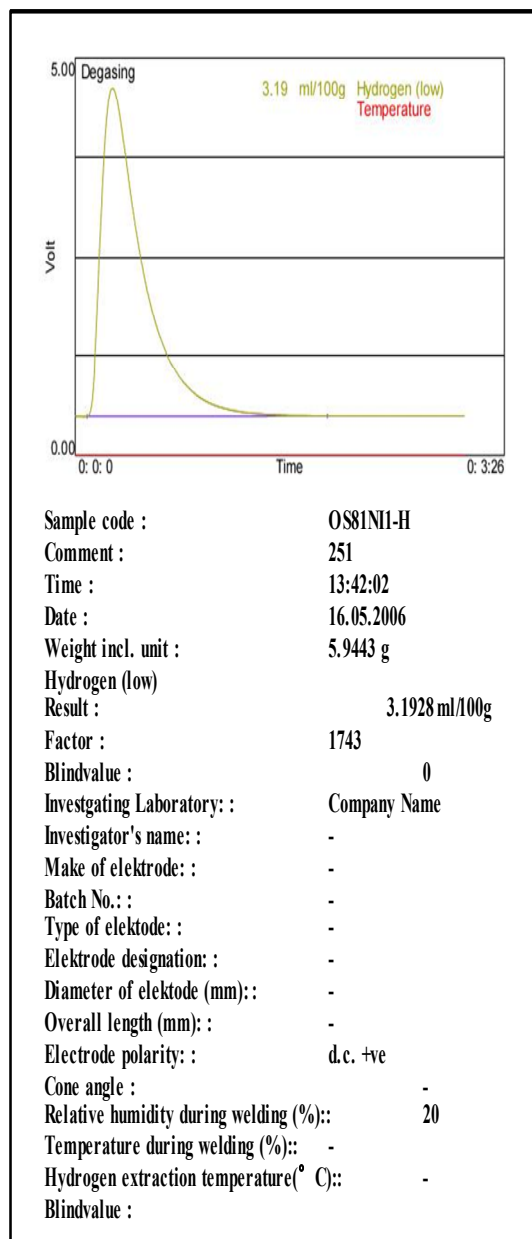
Elektrode:

Make of elektrode: _____ Batch No.: _____
 Type of elektrode: _____ Elektrode designation: _____
 Diameter of elektrode (mm): _____ Overall length (mm): _____
 Elektrode polarity: _____ Cone angle: _____
 Relative humidity: _____ (%) and Temperature: _____ (°C) at the welding station during welding.
 Hydrogen extraction temperature(°C): _____ Hydrogen extraction time (min): _____

Metal arc welding:
 Drying treatment: _____ °C for _____ h.

Submerged arc welding:
 Flux maker: _____ Flux batch No.: _____
 Flux drying temperature (°C): _____ Flux drying time (h): _____

Tubular cored electrode with or without gas shield and wire electrode with gas shield:
 Type of filler material: _____ Filler material designation: _____
 Diameter of filler material (mm): _____ Drying treatment: _____
 Shielding Gas: _____ Gas cup i.d (mm): _____



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