



第六届全国高校材料学科实验教学研讨会暨金相教学专题研讨会

典型金相样品制备

显微组织赏析

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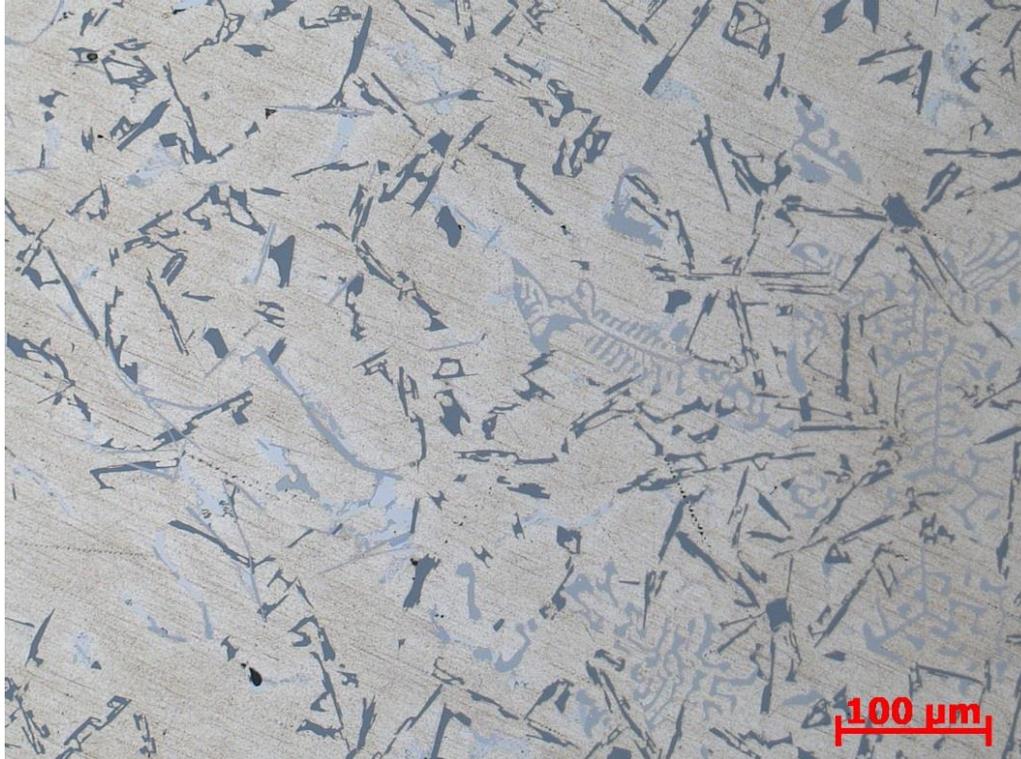
主要内容

 非铁材料样品制备之耗材

 非铁材料样品制备之设备（震动抛光）

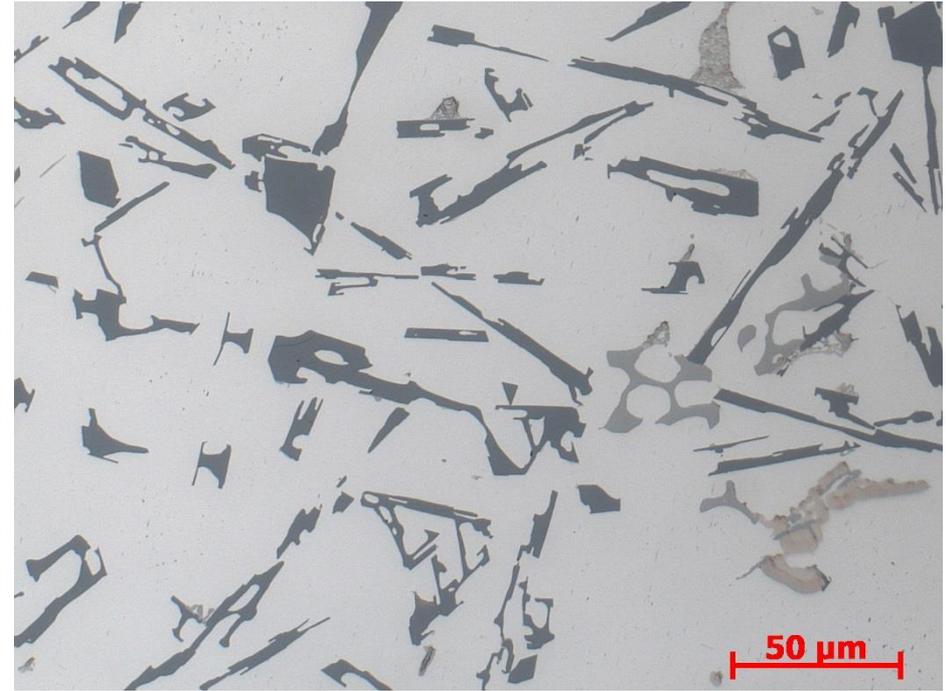
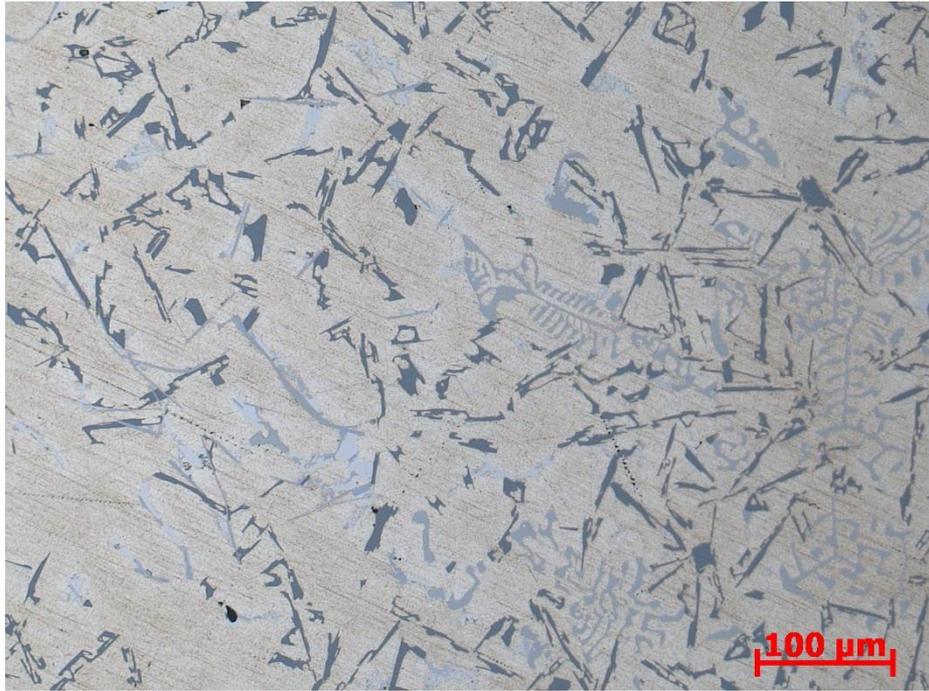
 显微组织赏析





铝硅合金





铝硅合金

0.06氧化铝溶凝胶

0.05氧化硅溶凝胶



制样步骤： 每一步都非常重要

取样

切割

镶嵌

研磨
和
抛光

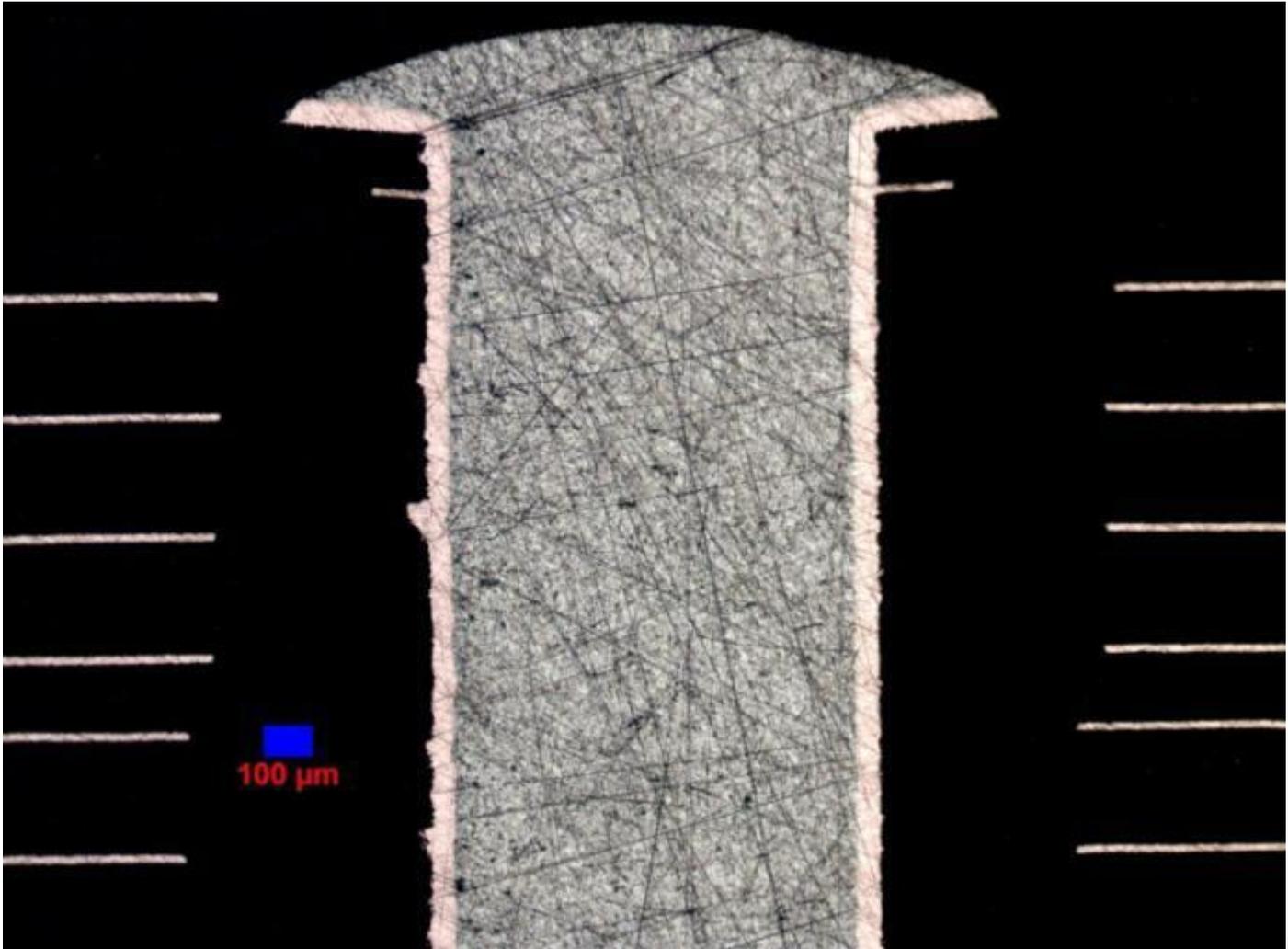
光学
检查

腐蚀

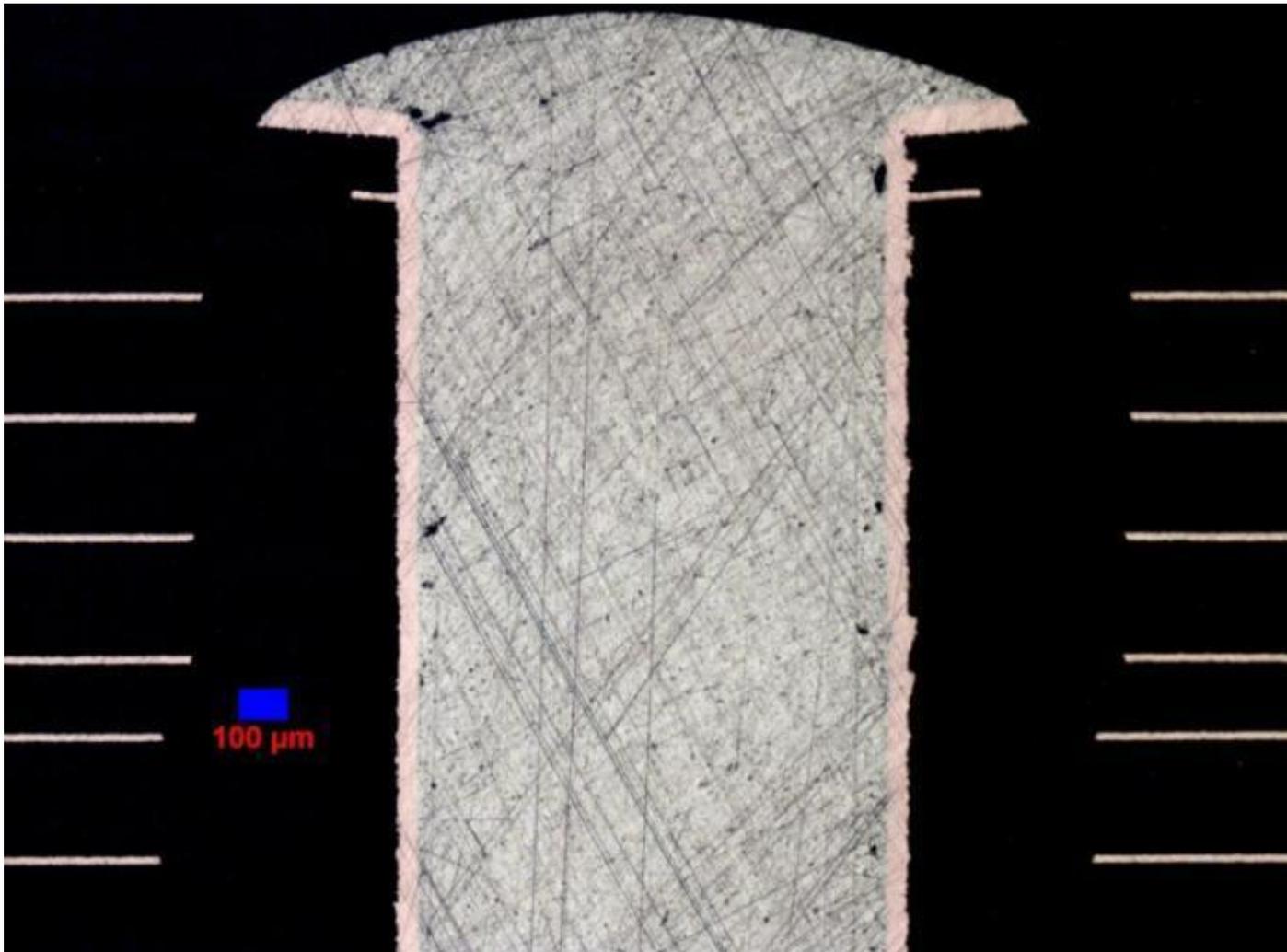
分析



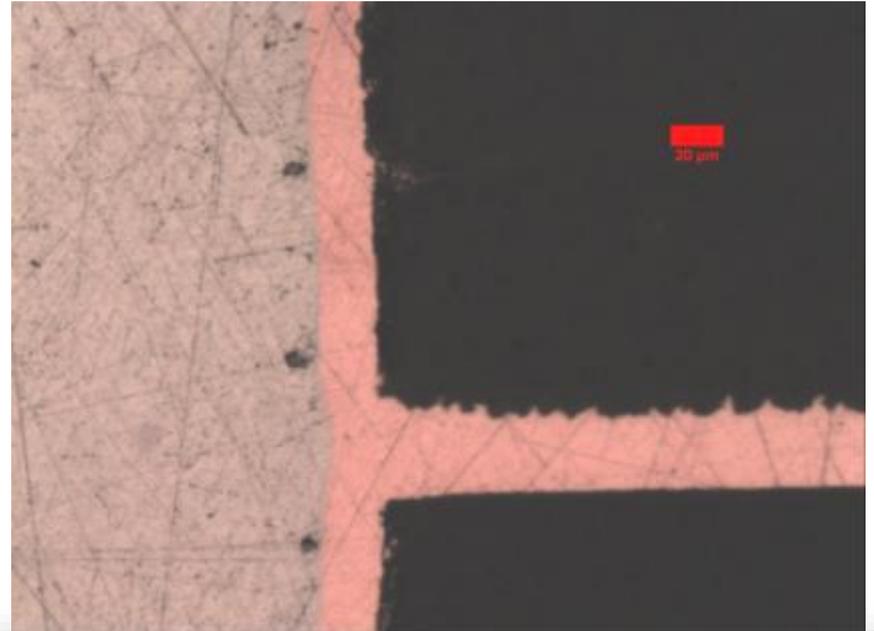
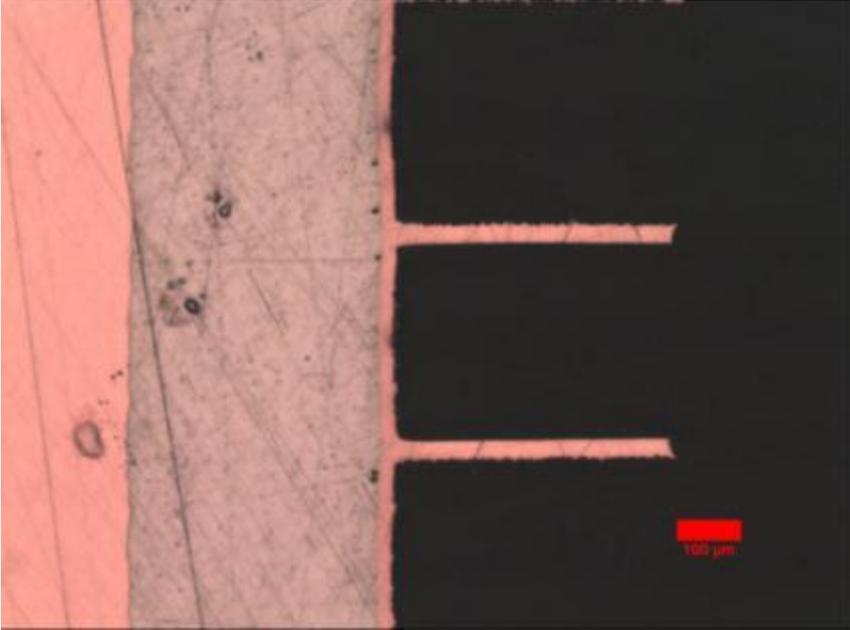
TriDent 9um 抛光



TriDent 3um 抛光



TriDent 1um 抛光(50x & 200x)





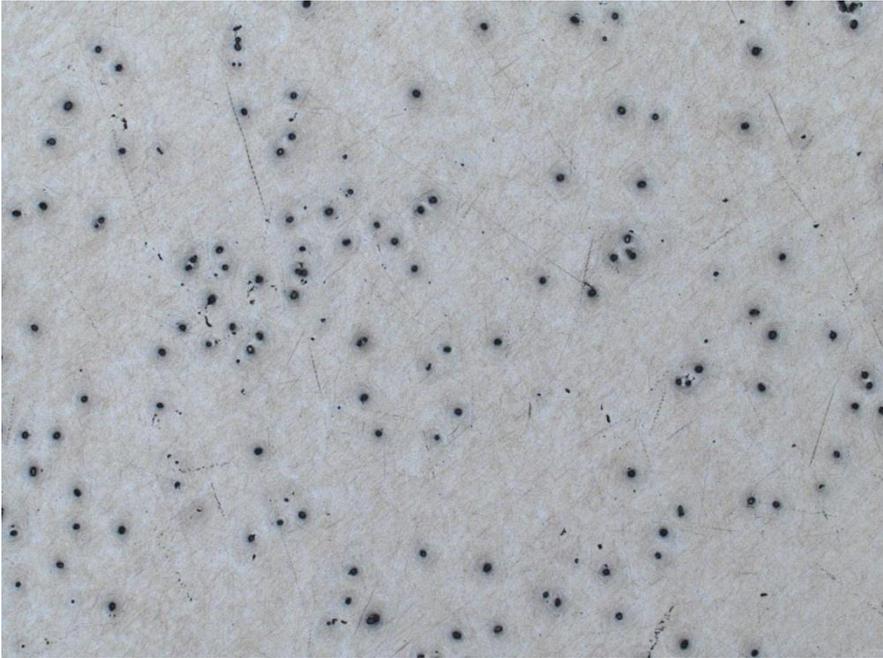
黑点有 $20\sim 50\ \mu m$ 大小

用力较重、不均

砂纸磨削不够，拖拽为主



粒子嵌入



1100铝合金，表面的小黑点为**9** 微米金刚石磨料颗粒
改变磨抛工艺，可消除



主要内容

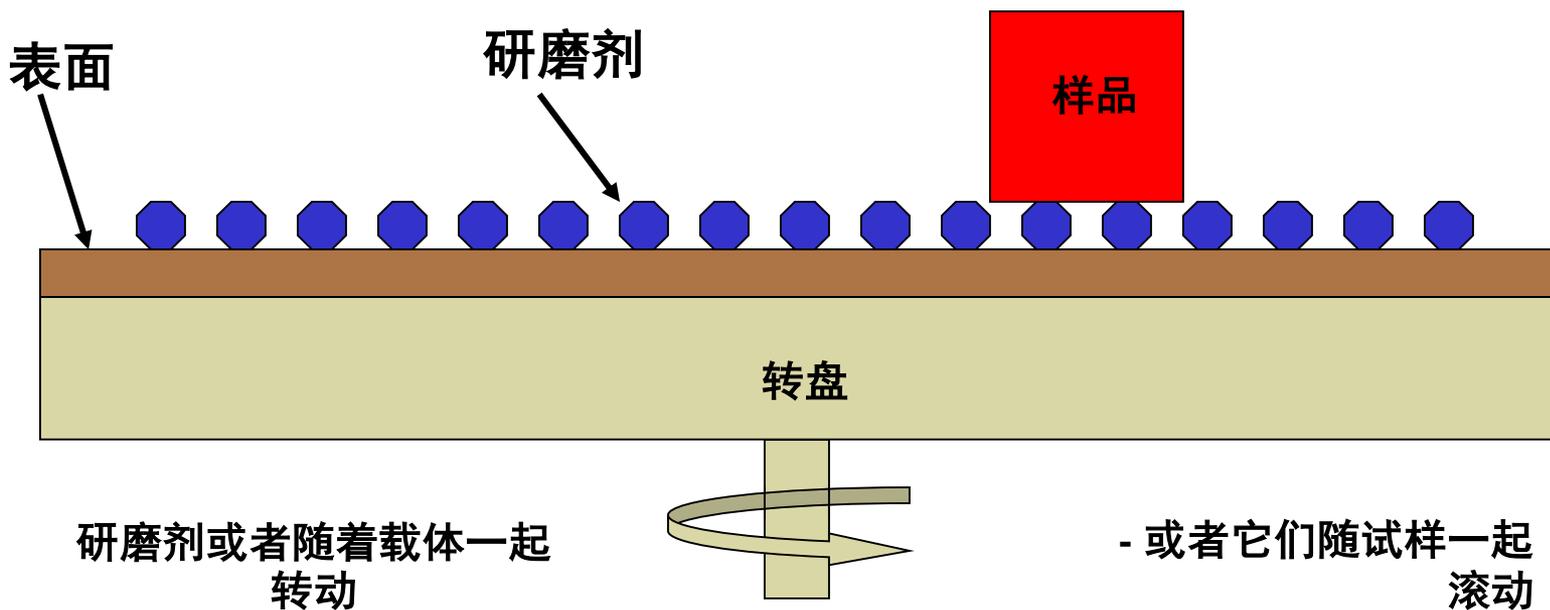
 非铁材料样品制备之耗材

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 显微组织赏析



影响显微磨削的2个主要因素



研磨剂--显微磨削使用的刀具

- 当研磨剂随着载体一起运动时（在同一水平上）我们称之为磨光
- 当研磨剂在载体上滚动时，称之为研磨
- 当研磨剂在去除材料的同时不产生可见的划痕时我们称之为抛光



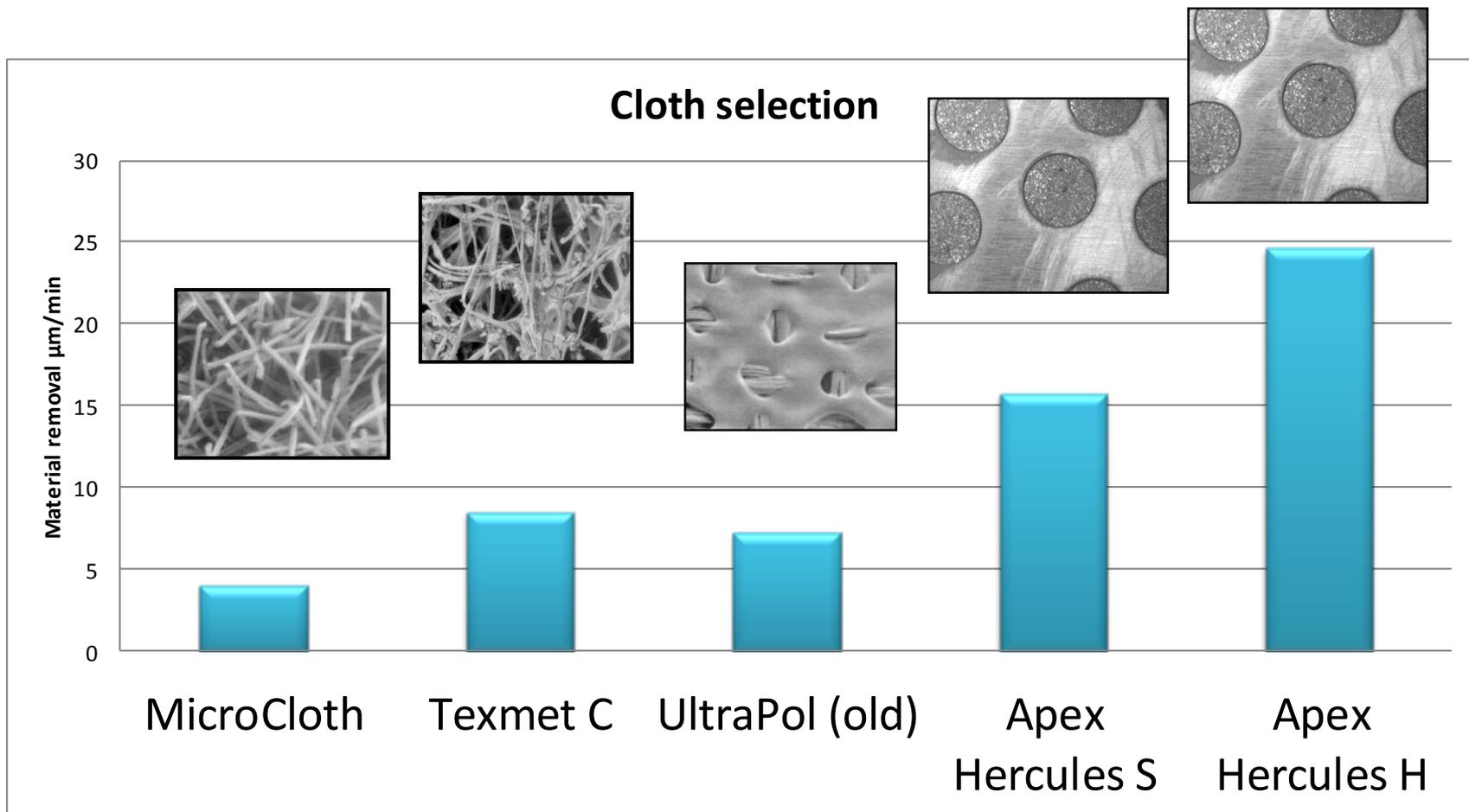
磨料和磨布的发展

国内有些厂家早已跟踪国外产品的发展，有改进，但更有差距！

衣料级呢绒布（不够致密），手工制作尚可
磨料：含量 $\geq 70\%$



国外磨抛布对材料去除的影响



9 μm 金刚石颗粒，压力一致

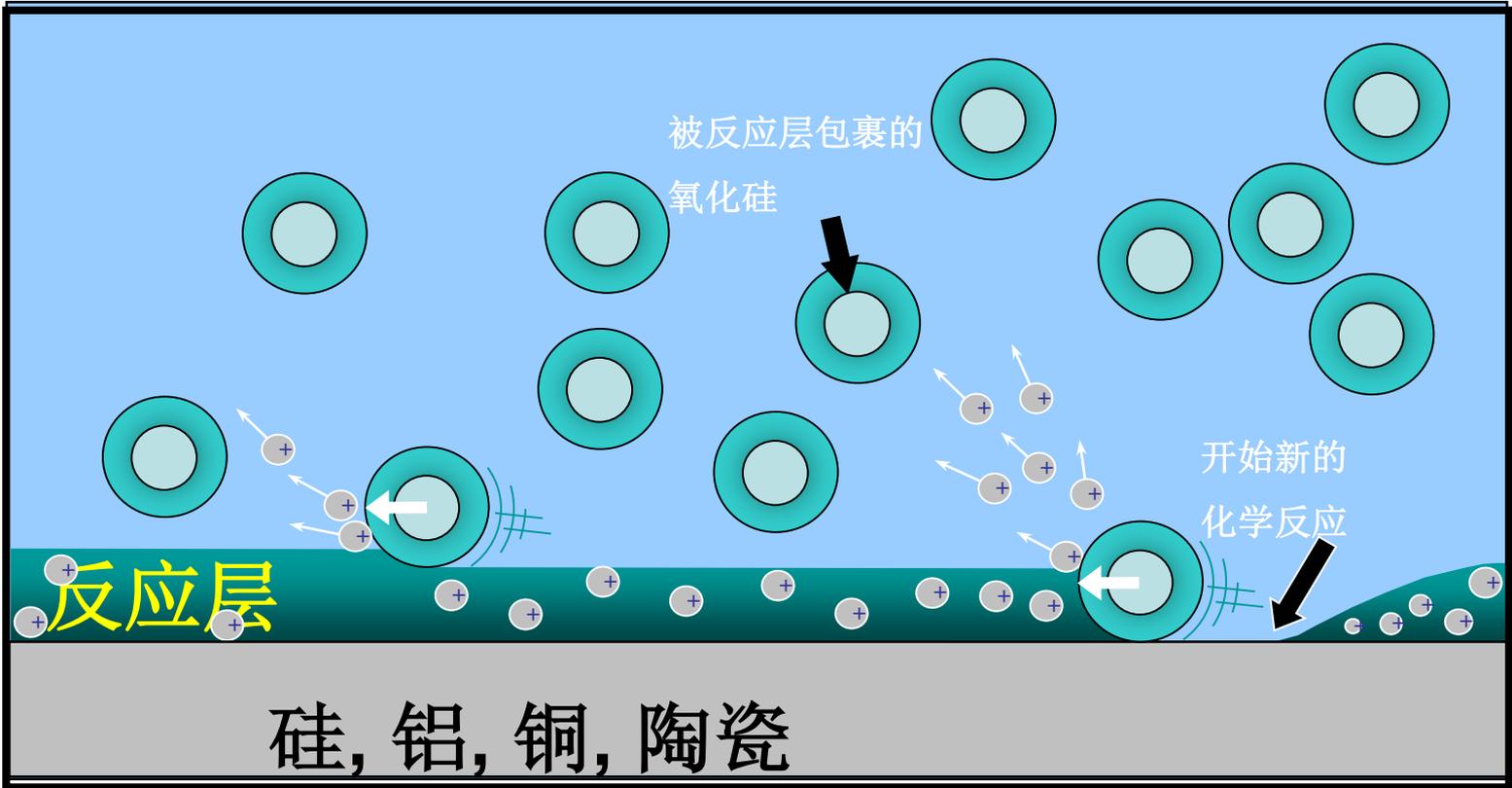


抛光液的选择 (化学抛光)

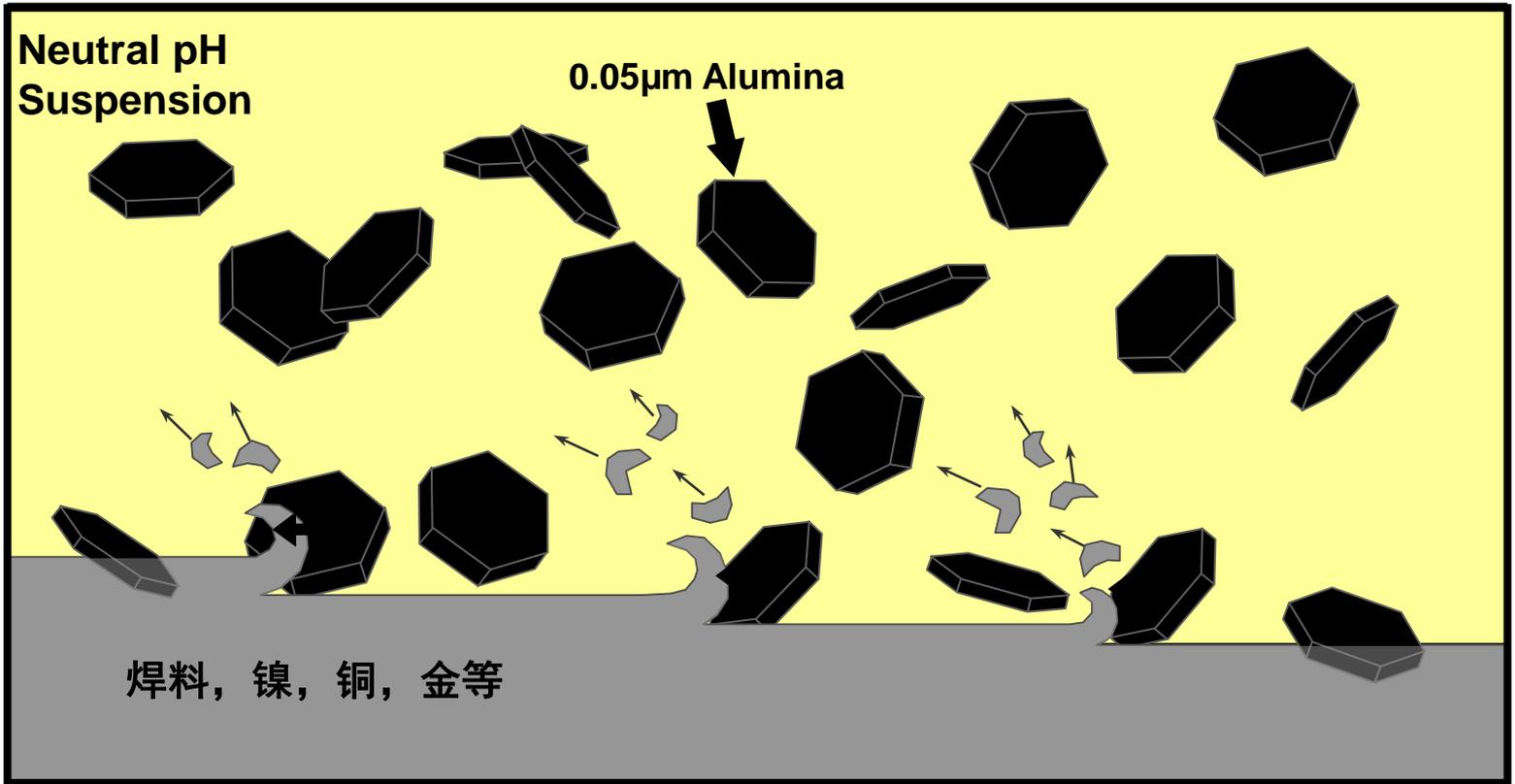
氧化硅溶胶-凝胶	氧化铝溶胶-凝胶
有色金属	钢
印刷电路板	铸铁
Al, Cu, Ni 合金	难熔金属
Pb, Sn, 焊料	碳化物
塑料	高温合金
印刷电路板	



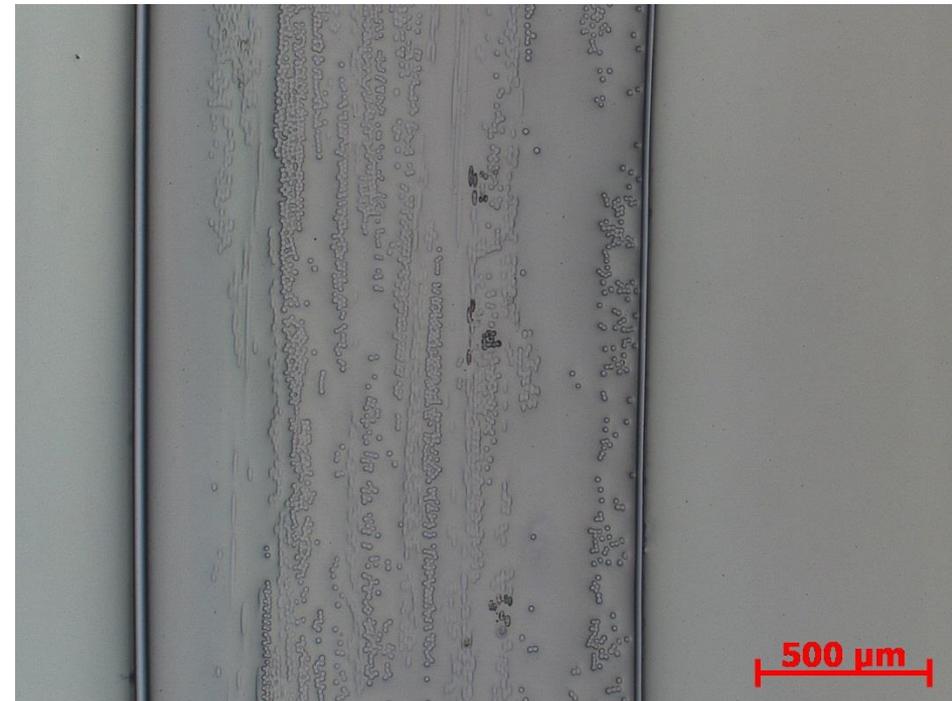
氧化硅抛光



氧化铝抛光



塑料样品金相制样

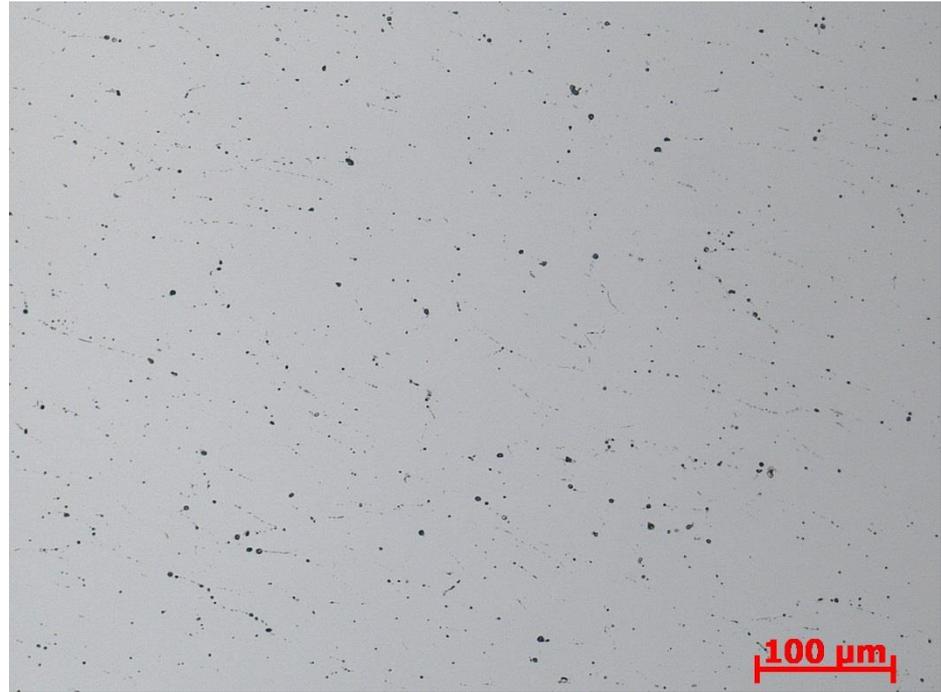
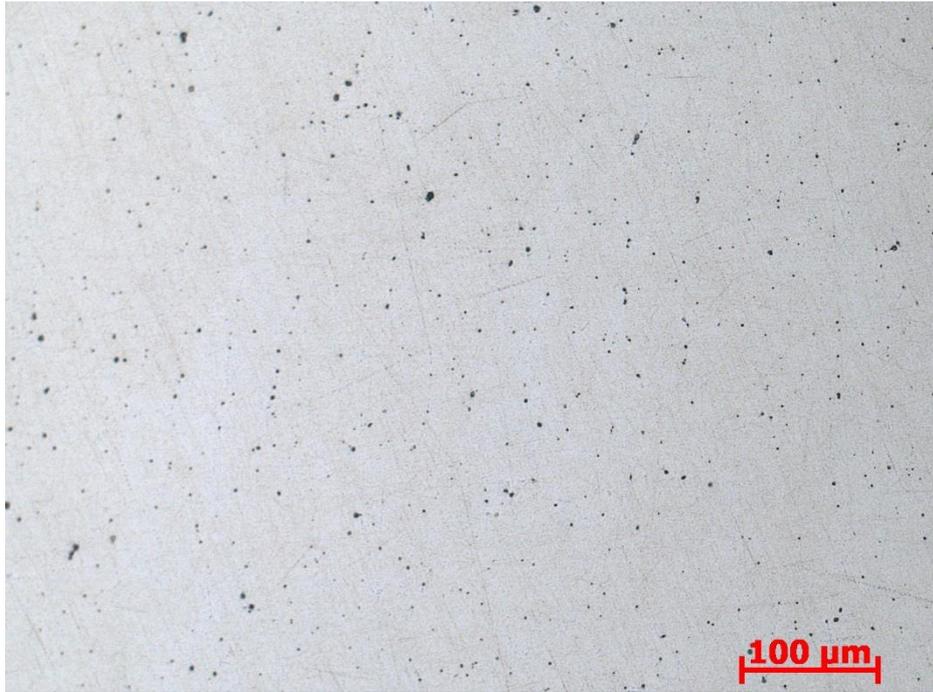


0.06氧化硅溶凝胶



0.05氧化铝溶凝胶





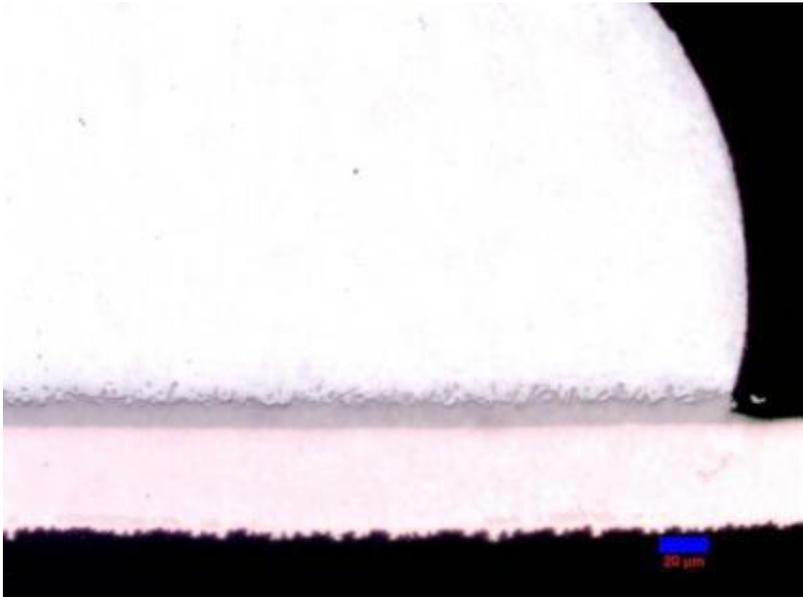
6061 铝合金

0.06 氧化铝溶凝胶

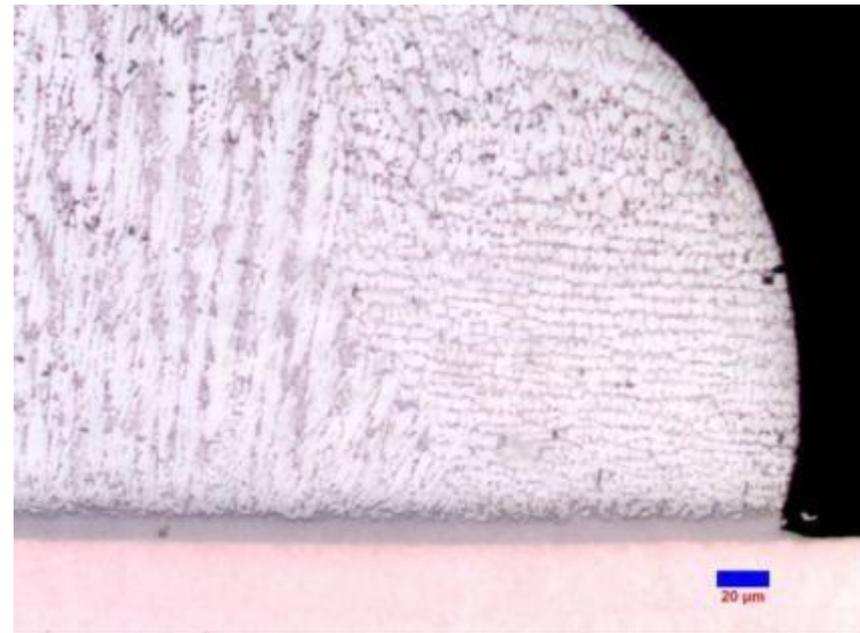
0.05 氧化硅溶凝胶



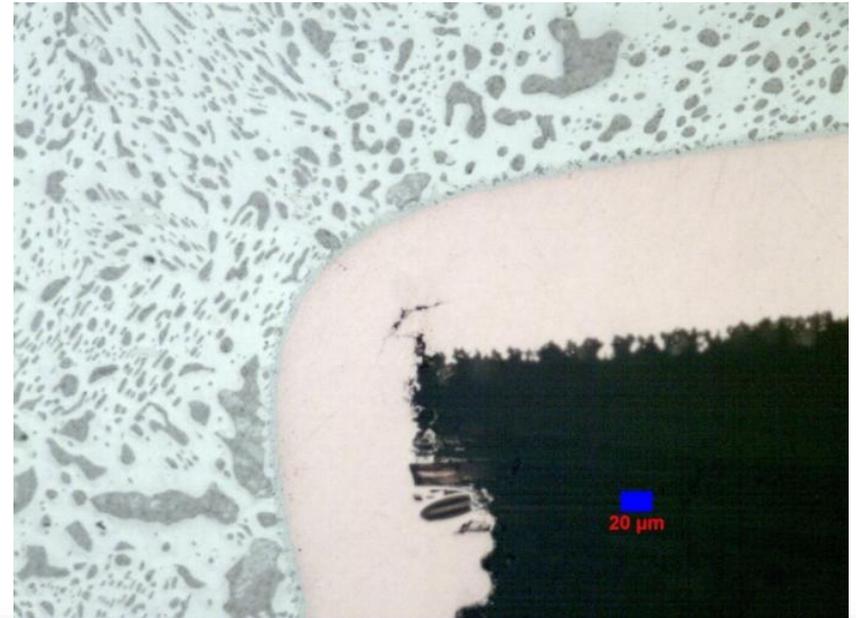
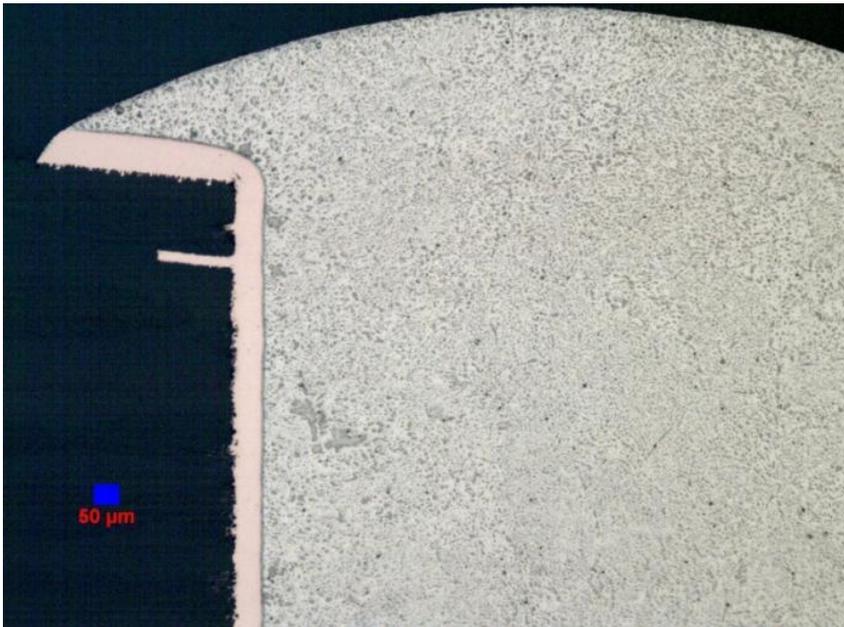
0.05um Al₂O₃ (Normal pH)



0.06um SiO₂ (High pH)



精抛, 0.06 μm SiO₂溶胶



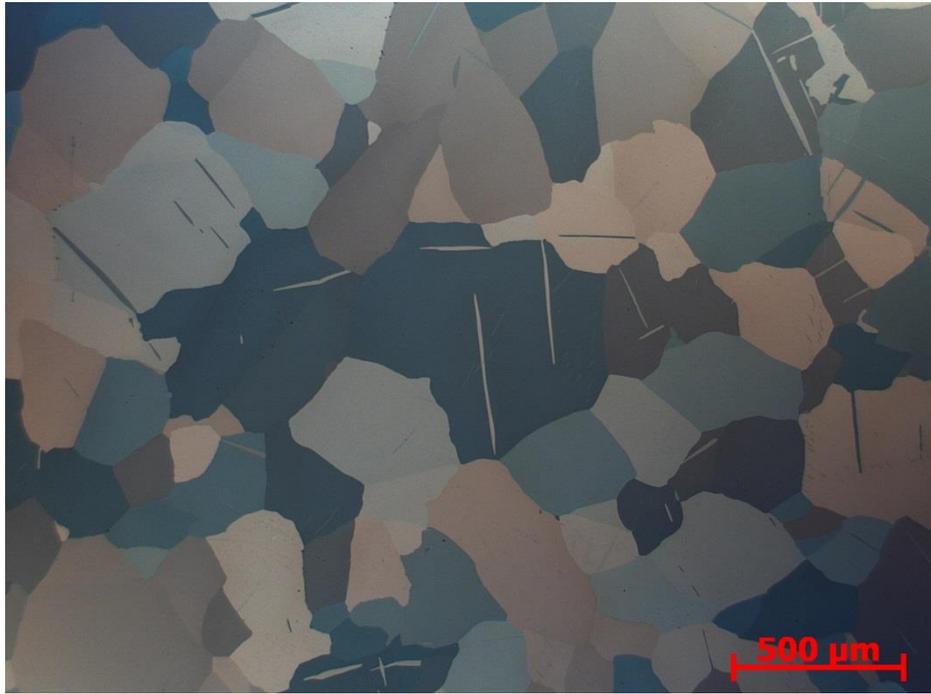


纯 锌

0.06氧化铝溶凝胶

0.05氧化硅溶凝胶





纯锌 圆偏光下，转动 90° ，明暗交变



主要内容

 非铁材料样品制备之耗材

 非铁材料样品制备之设备（震动抛光）

 显微组织赏析



振动抛光

- 适用于易拖尾的材料
- 接近100%的水平振动
- 温和抛光
- 主要可用于难以制备的材料
- 去除残余制备变形和划痕
- 适用于SEM/EBSD 测试前处理



粒子嵌入



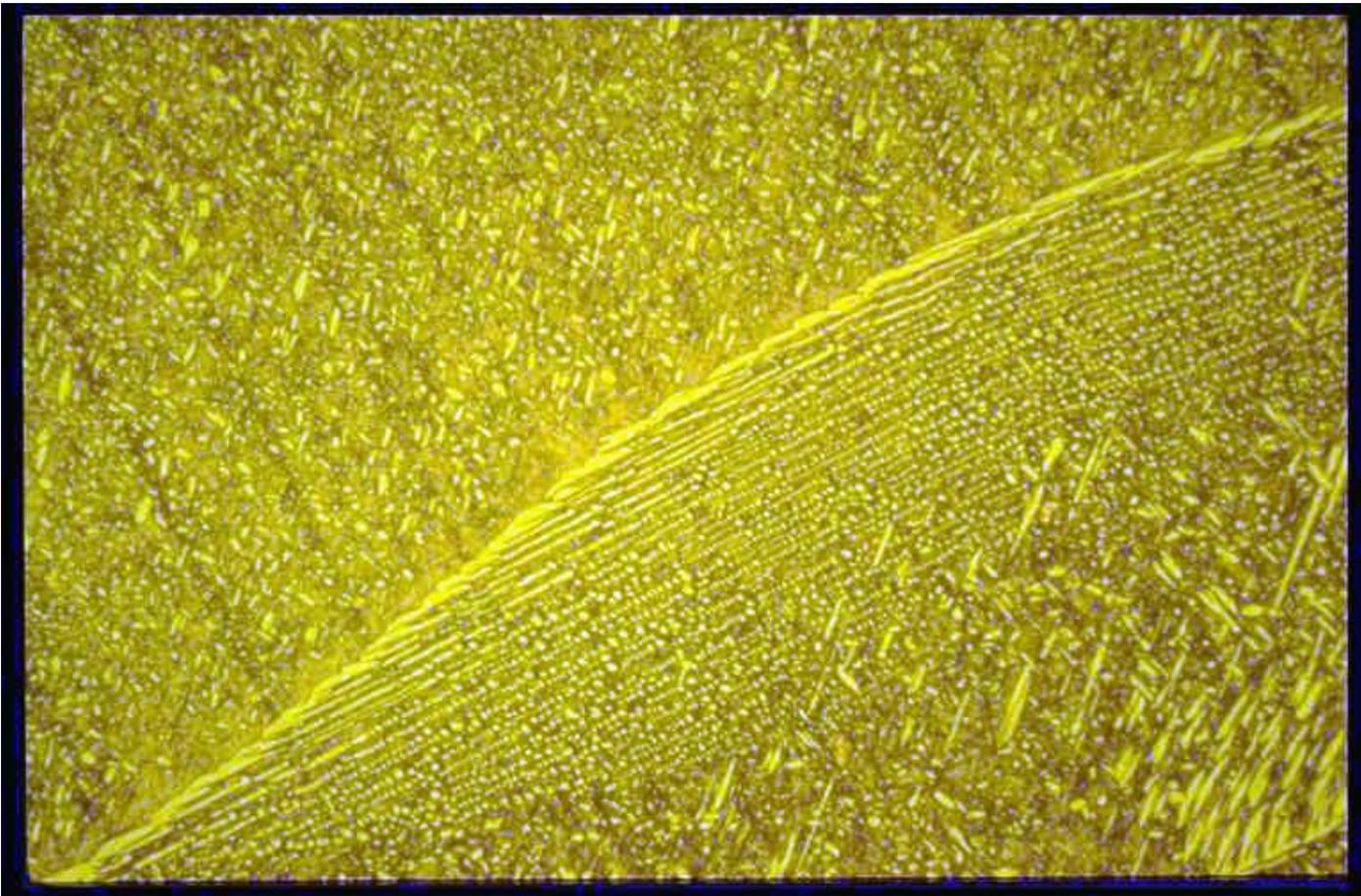
表面的小黑点疑为3 微米金刚石磨料颗粒

采用振动抛光后,消除了金刚石颗粒



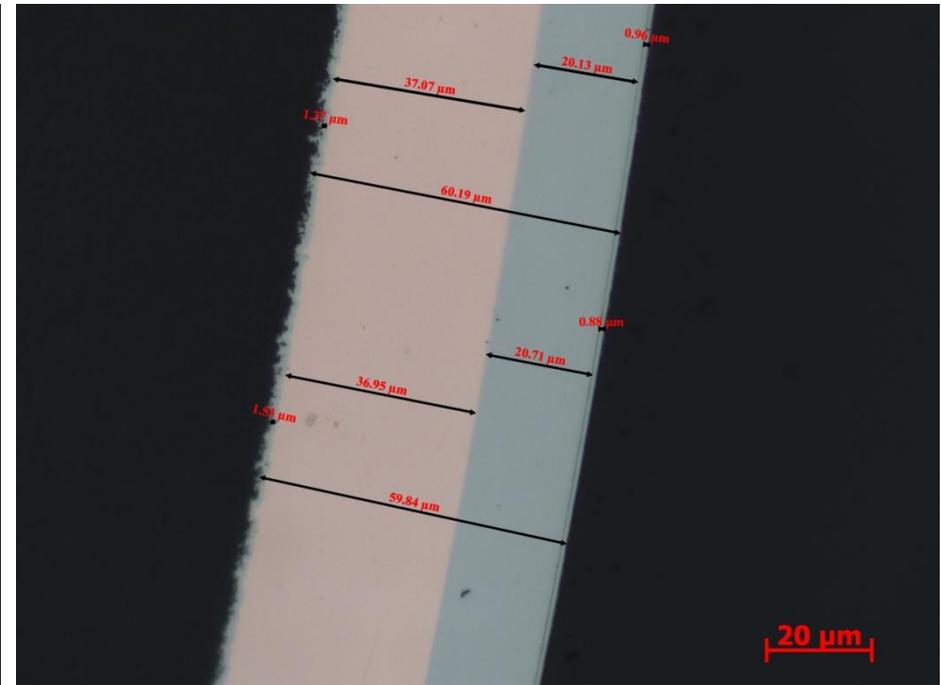
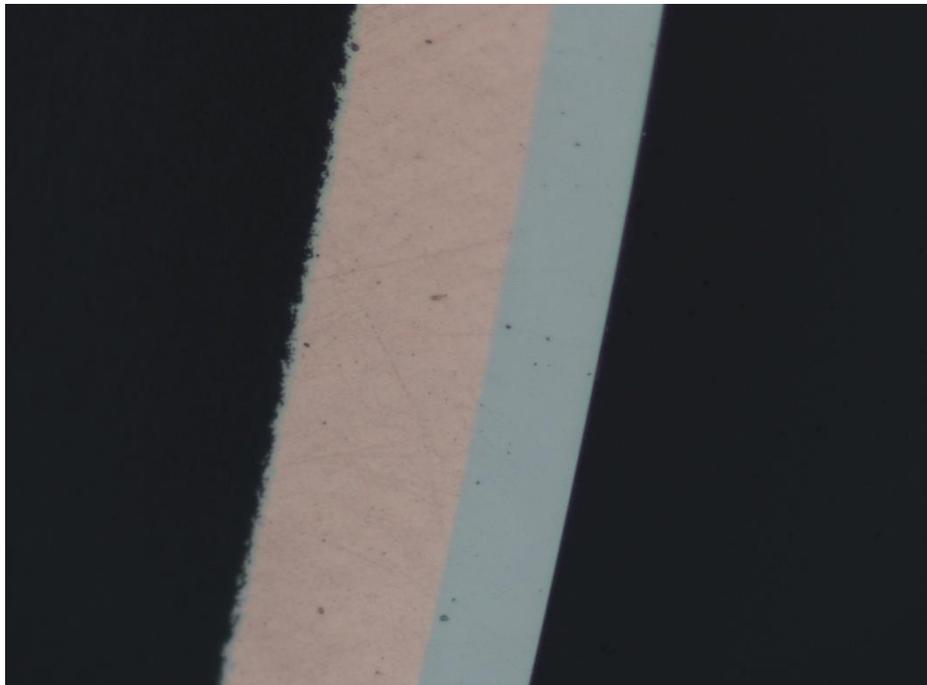
黄铜试样抛光腐蚀后的显微组织 (明视场照明, 500X)

(倾斜的粗黑线在腐蚀前并未出现, 因此不是磨痕, 而是由于变形损伤没有完全去除, 使残余应变区产生择优腐蚀所致)



震动抛光

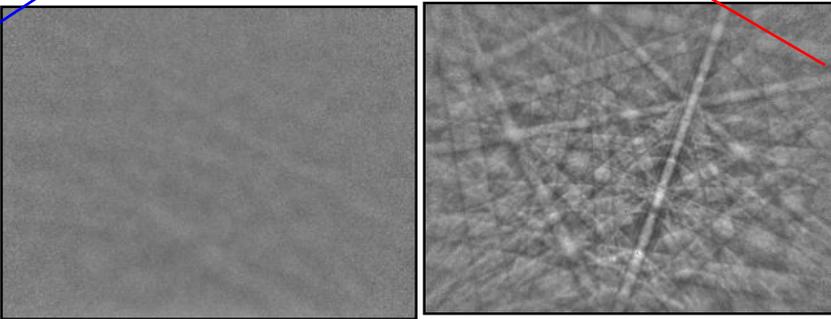
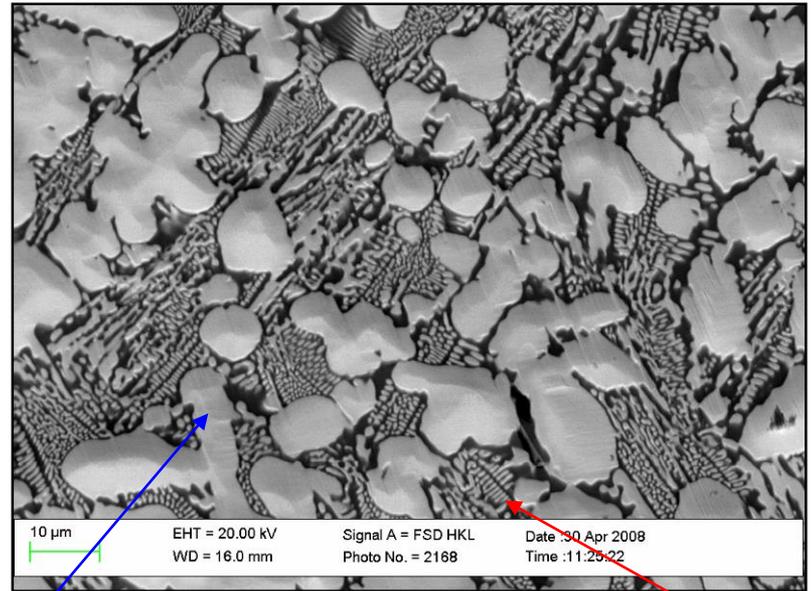
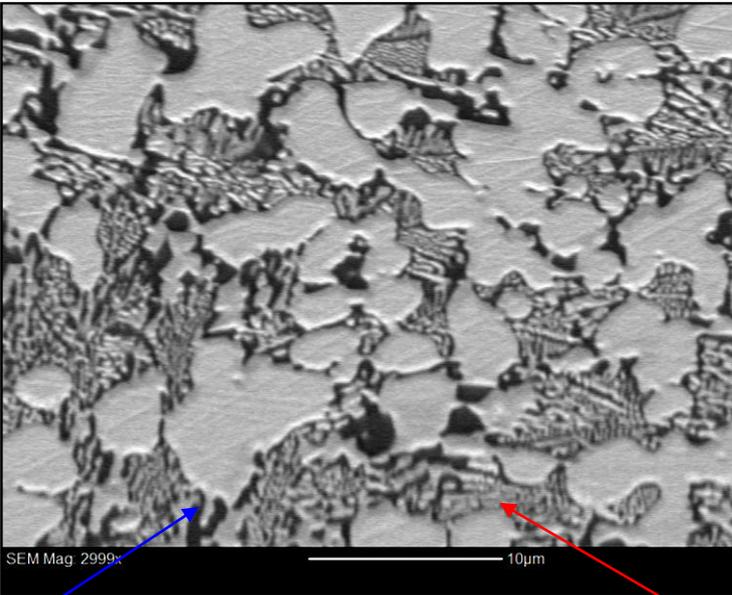
增加一个震动抛光(可以与最后步骤使用相同的抛光介质), 可以提高划痕的去除能力, 特别可以区分表层非常薄的镀层界面与精细结构!



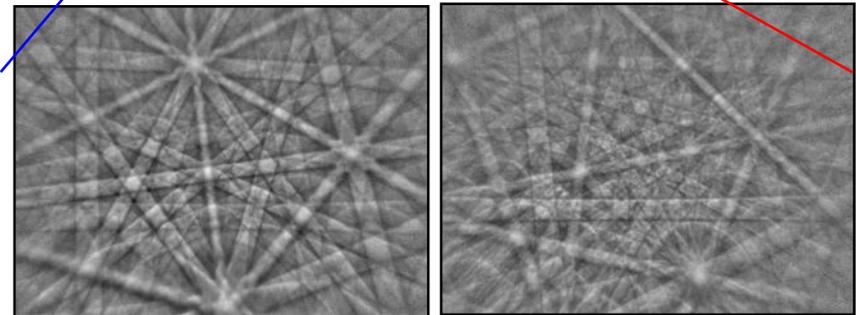
塑料件电镀层



样品制备对清晰度、EBSD图像影响



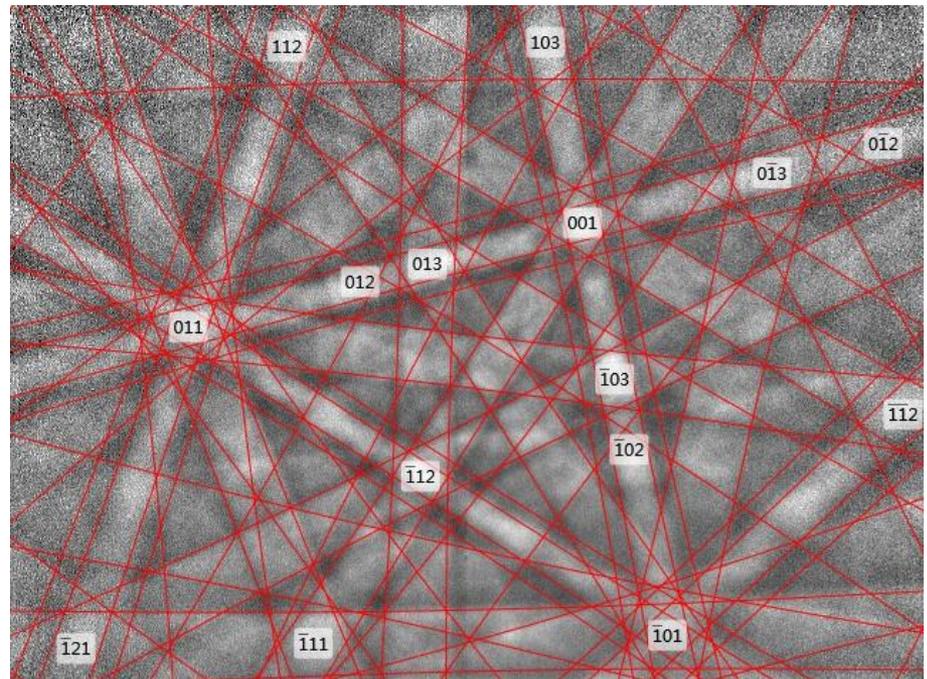
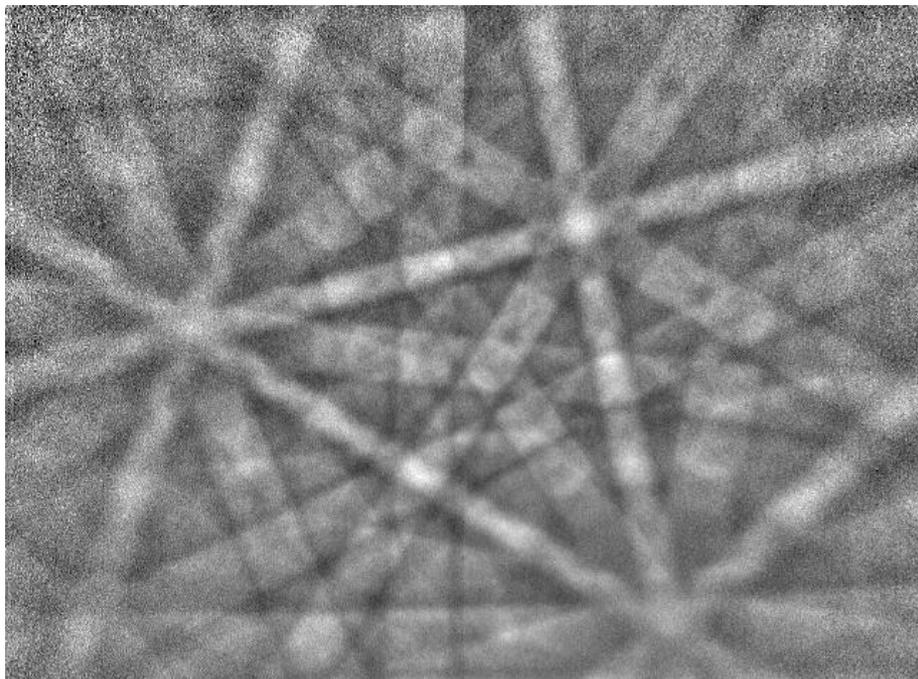
普通的样品



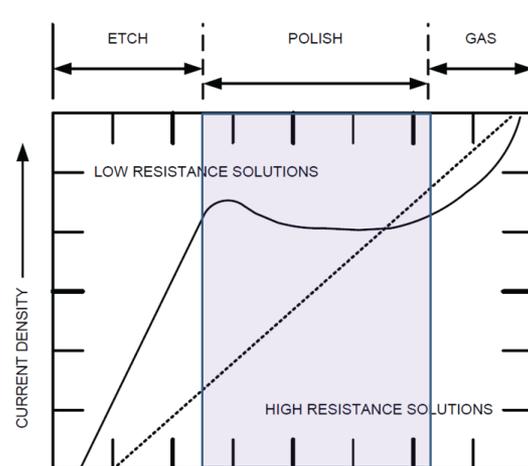
好的样品制备



纯铜的EBSD衍射花样



电解抛光技术应用 及彩色腐蚀





316L 不锈钢

磷酸硫酸电解 3.6V 30S



6061铝, 电解+偏光



主要内容

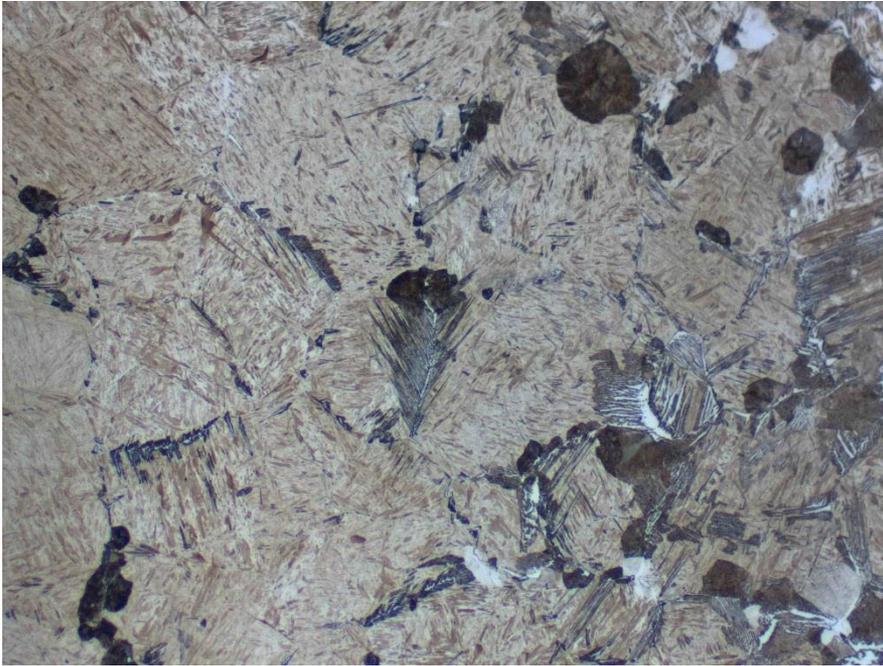
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 显微组织赏析

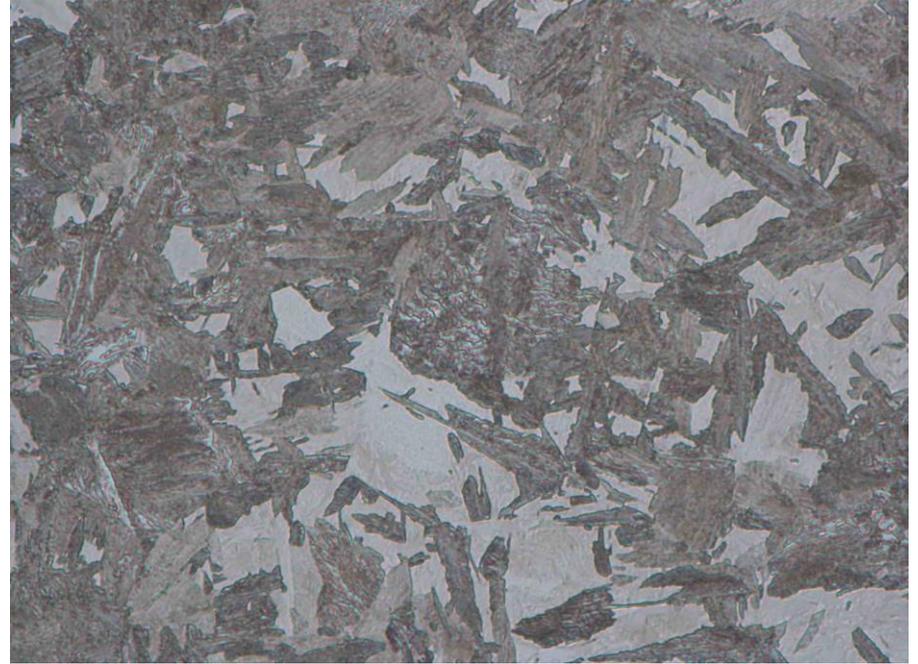


理论与实际的偏差



45#钢

组织：上贝氏体+屈氏体+马氏体

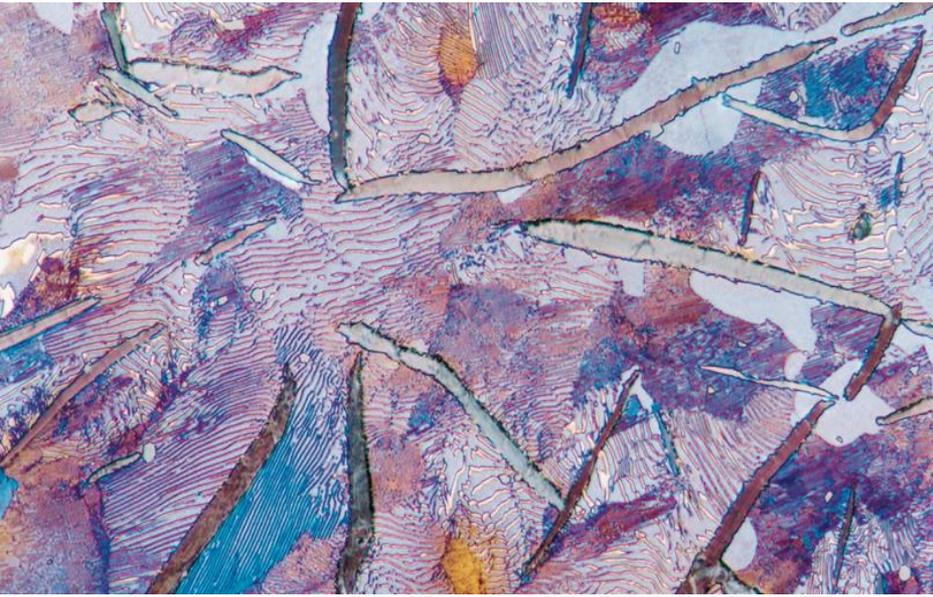


65Mn钢

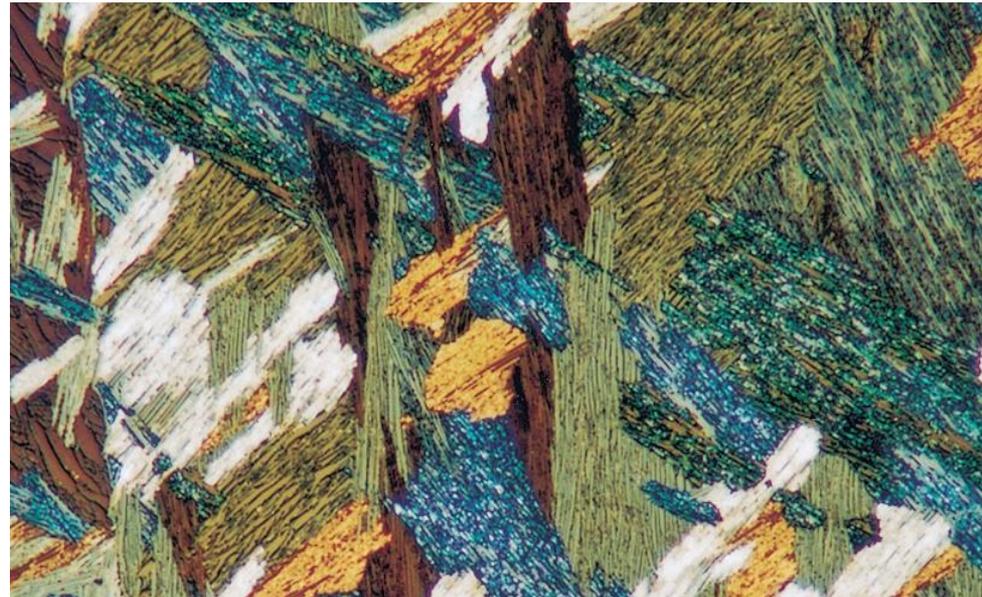
840 °C 保温，450°C等温

组织：上贝氏体+马氏体



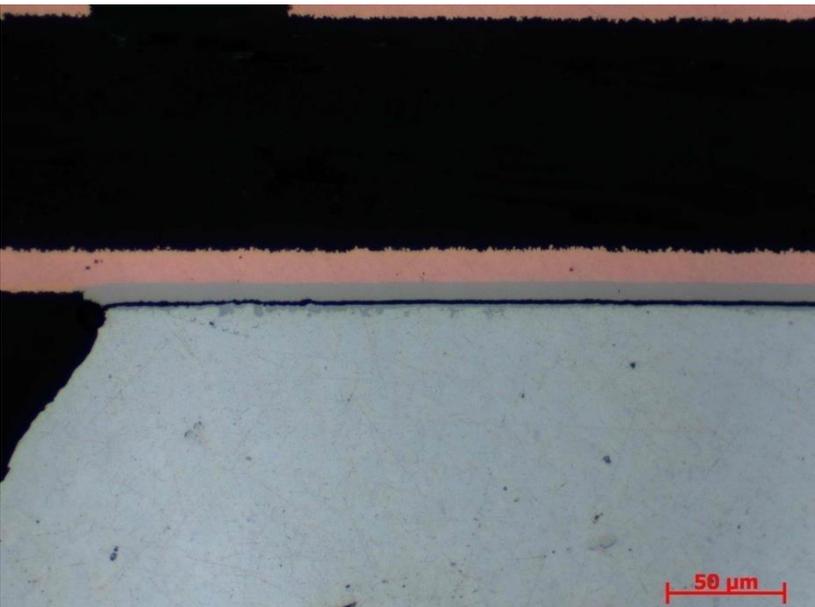
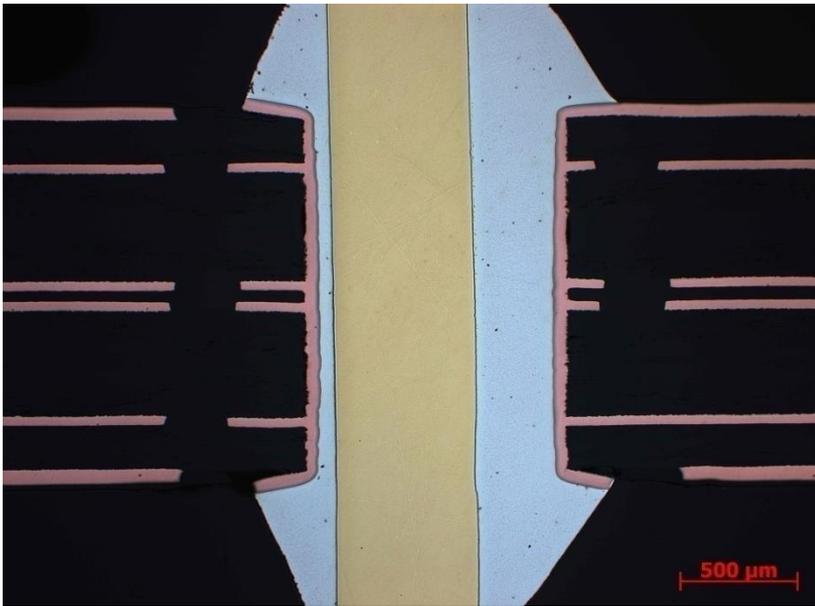


灰铸铁(染色法)



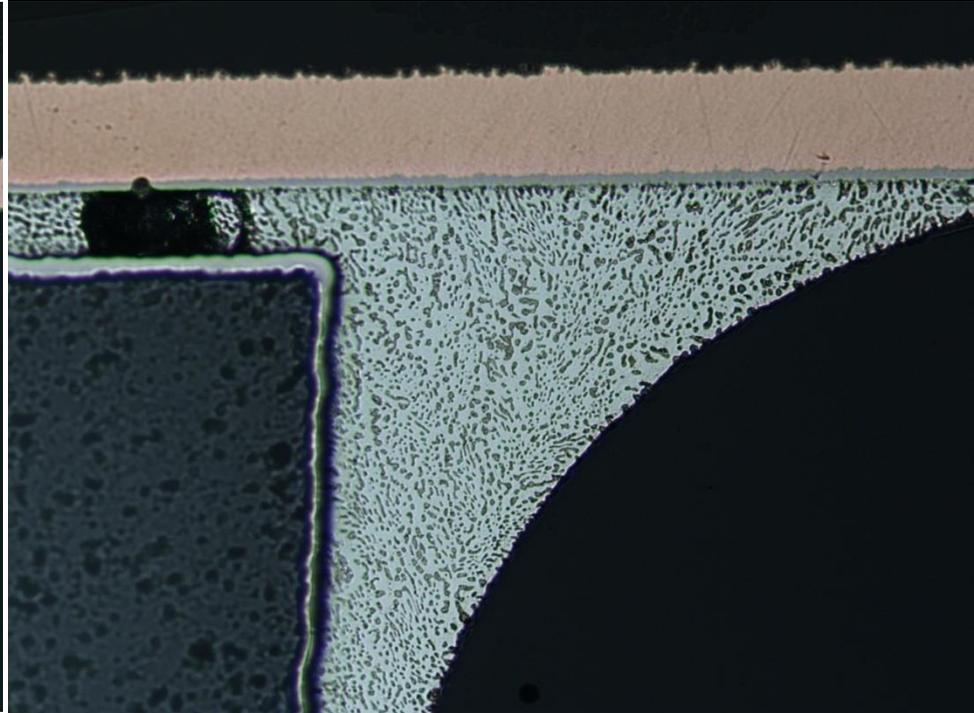
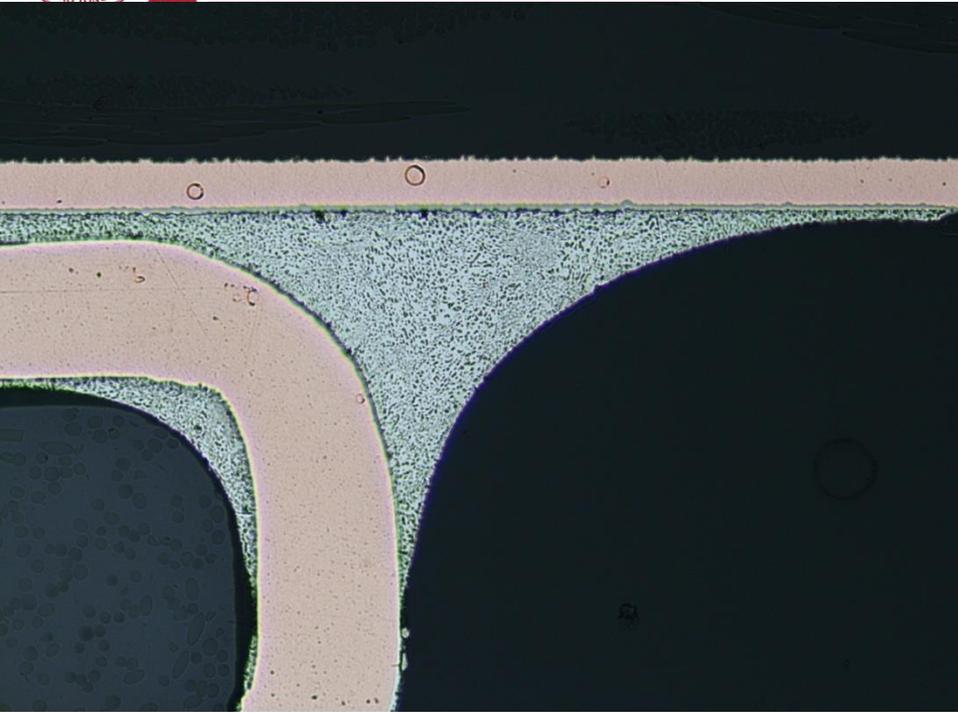
Ti6Al4V, α + β 染色+偏光

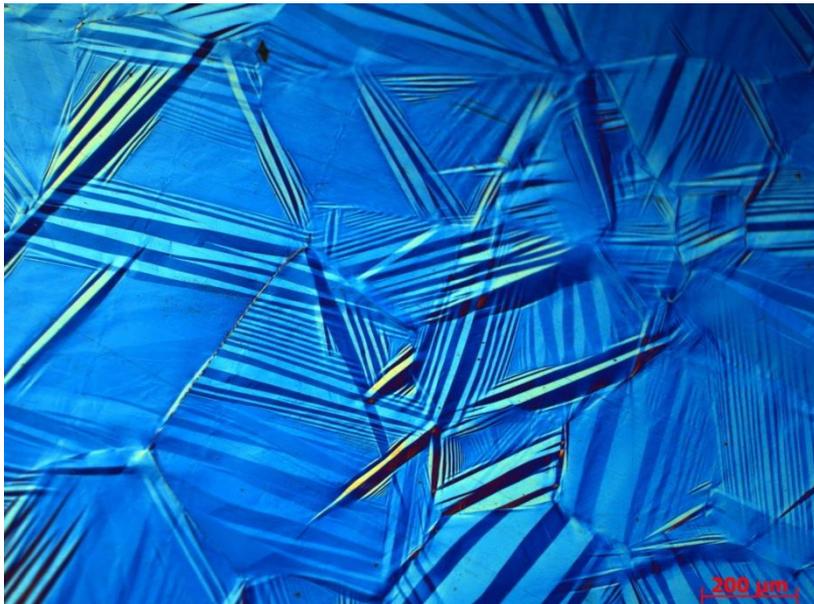




PCB板焊点：
铜，镍，锡-银

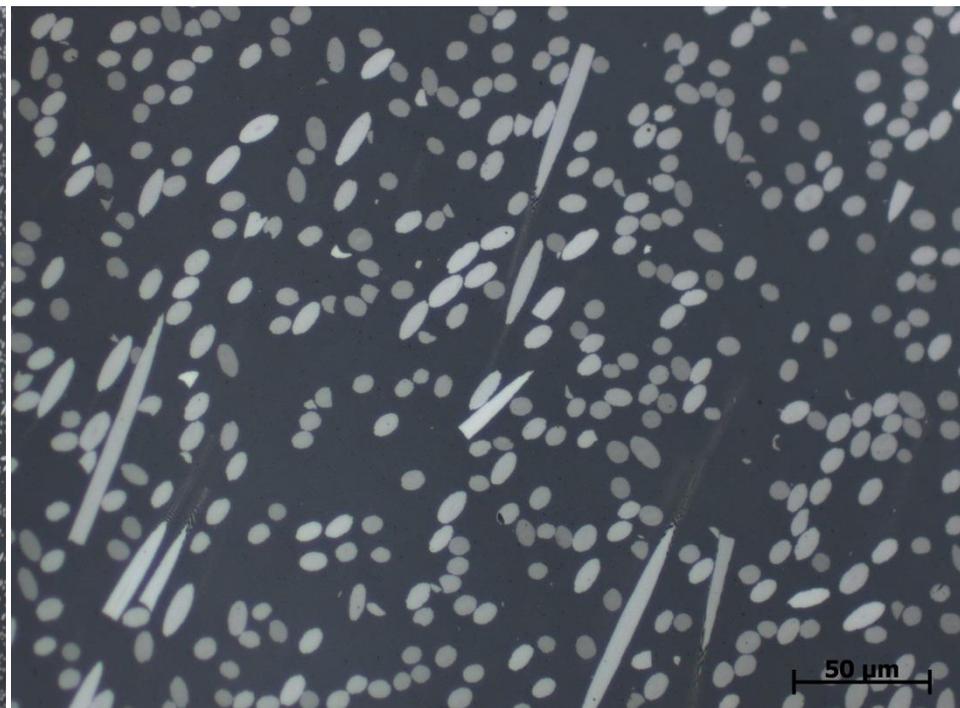
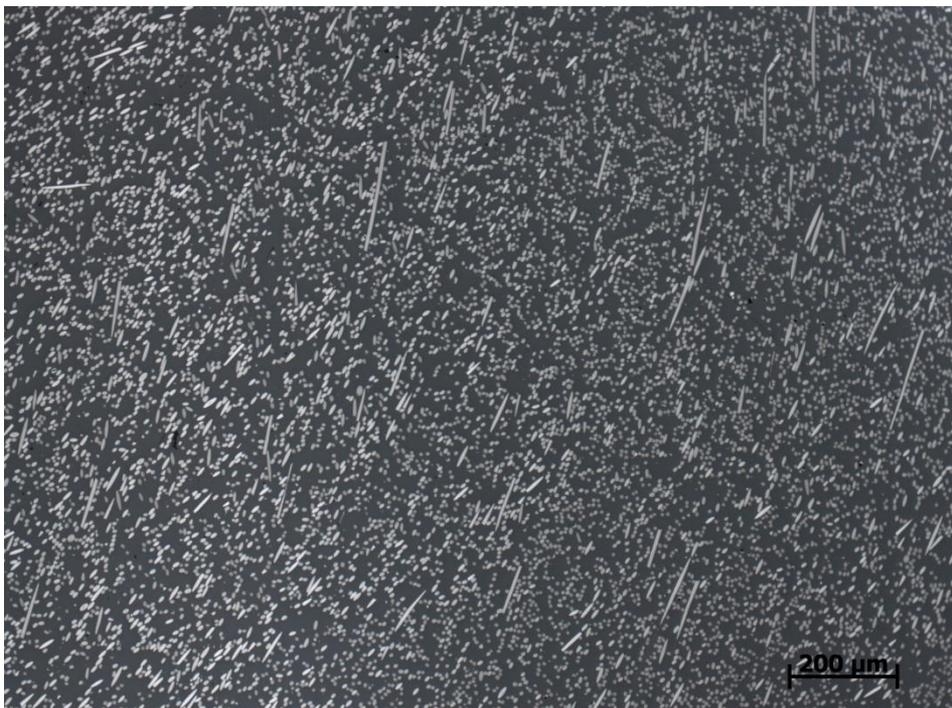






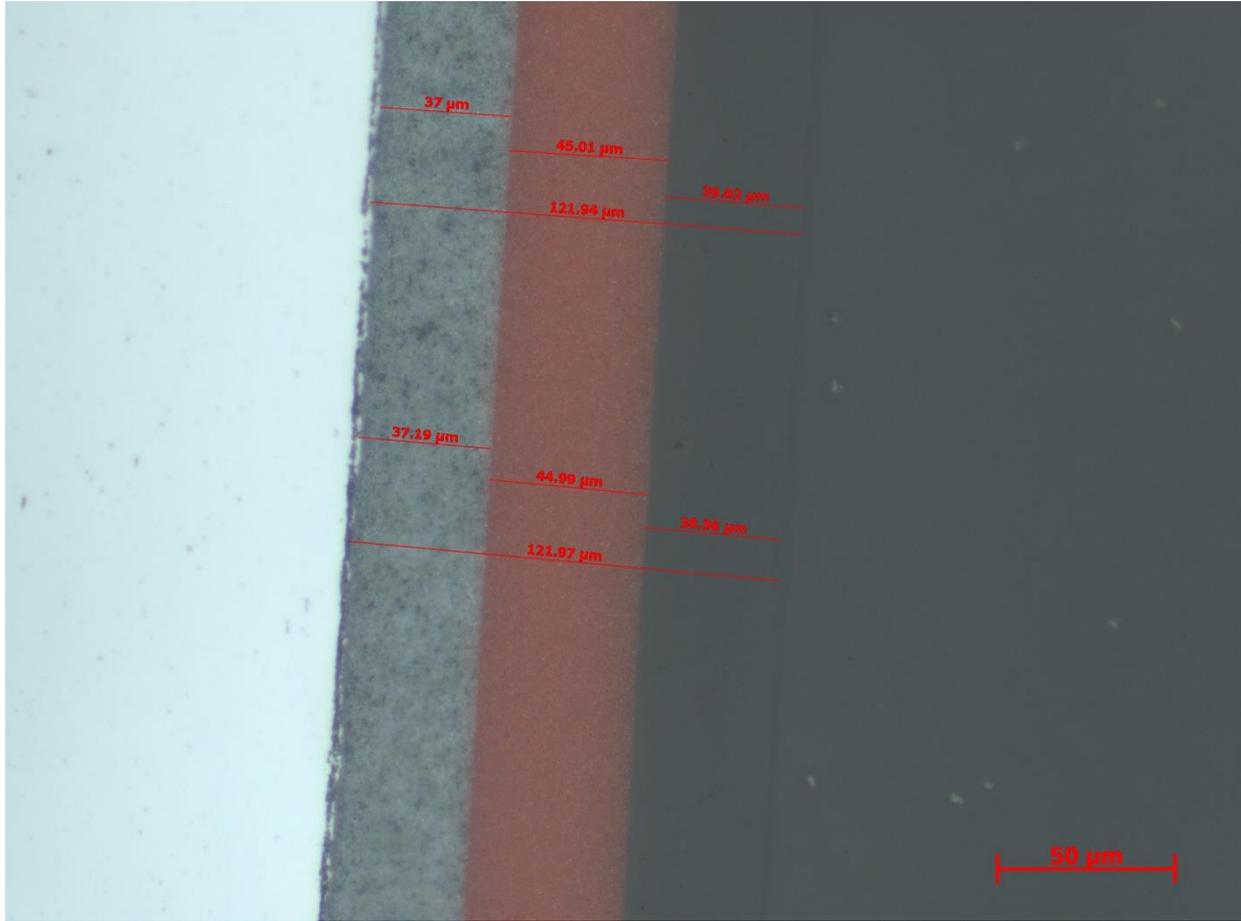
18K黄金马氏体组织





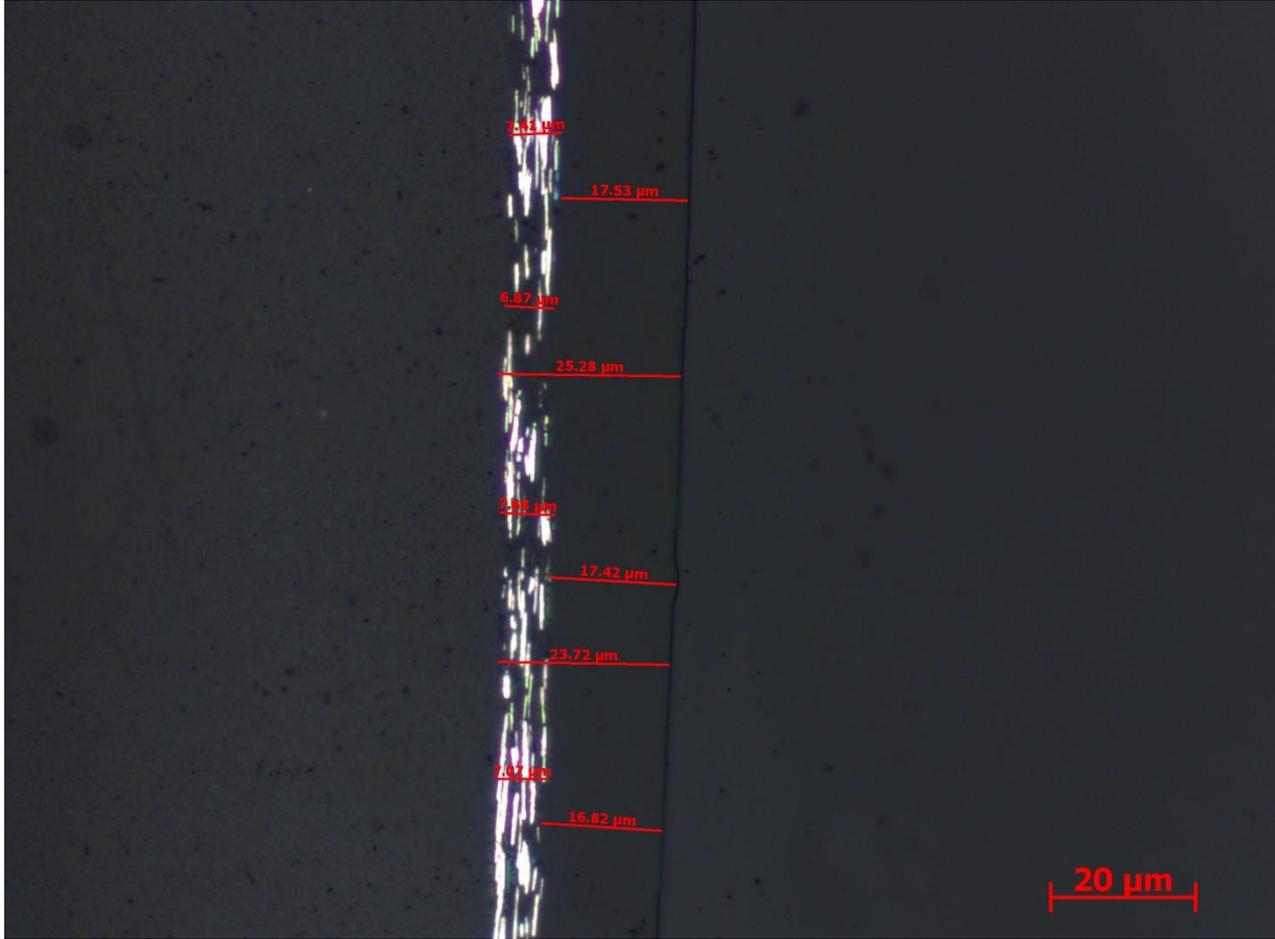
碳纤维增强塑料





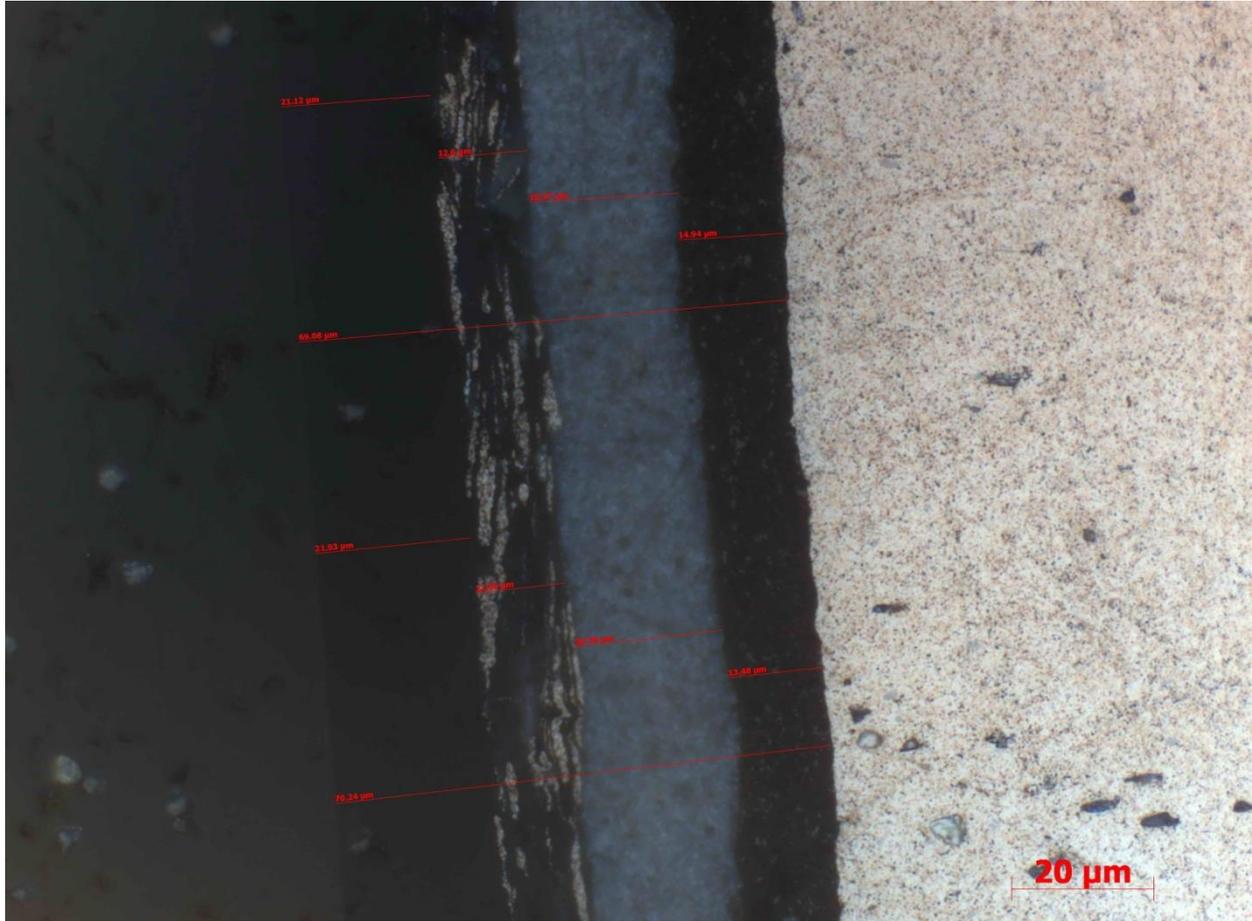
多层油漆涂层





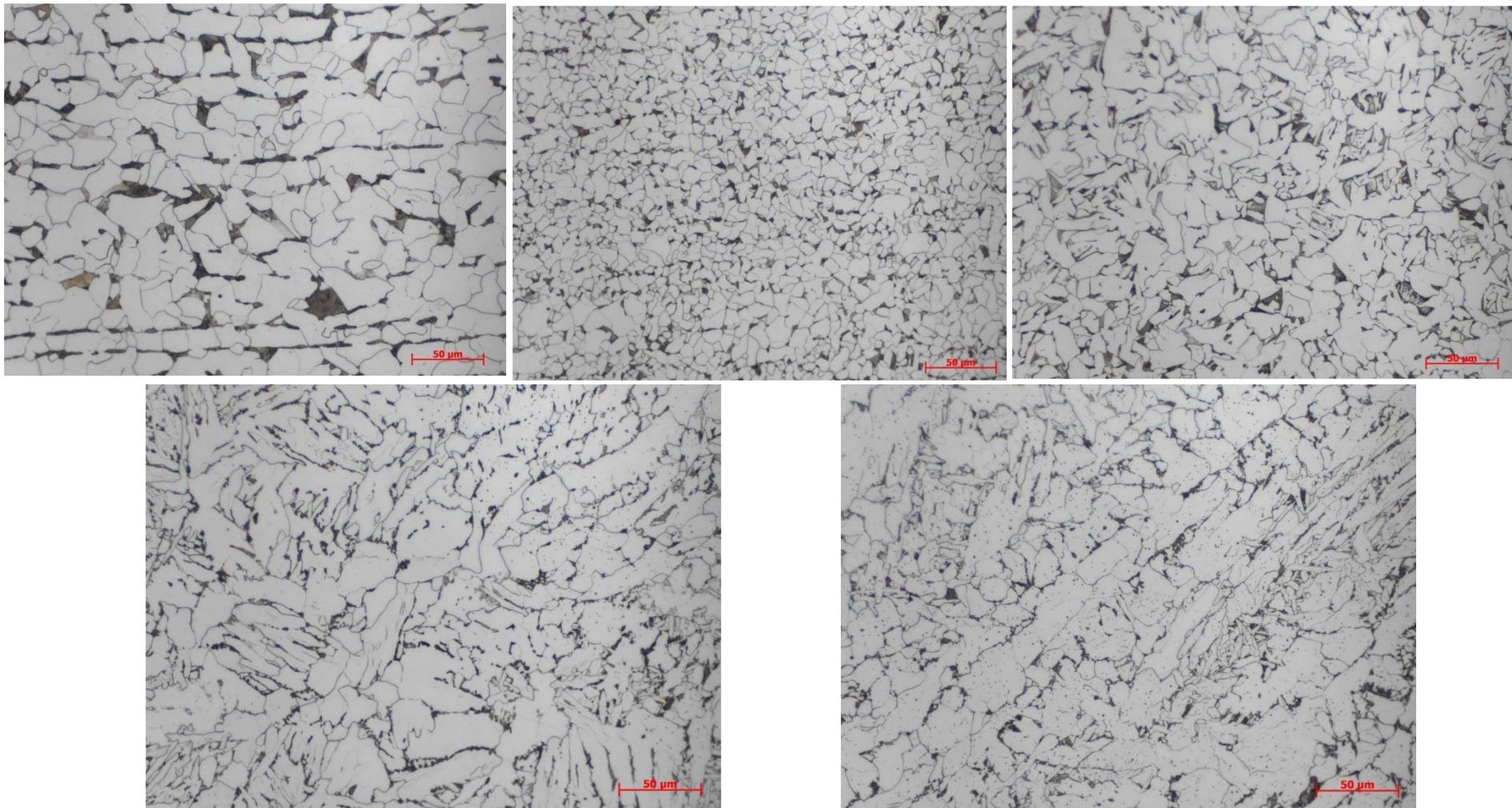
金属漆





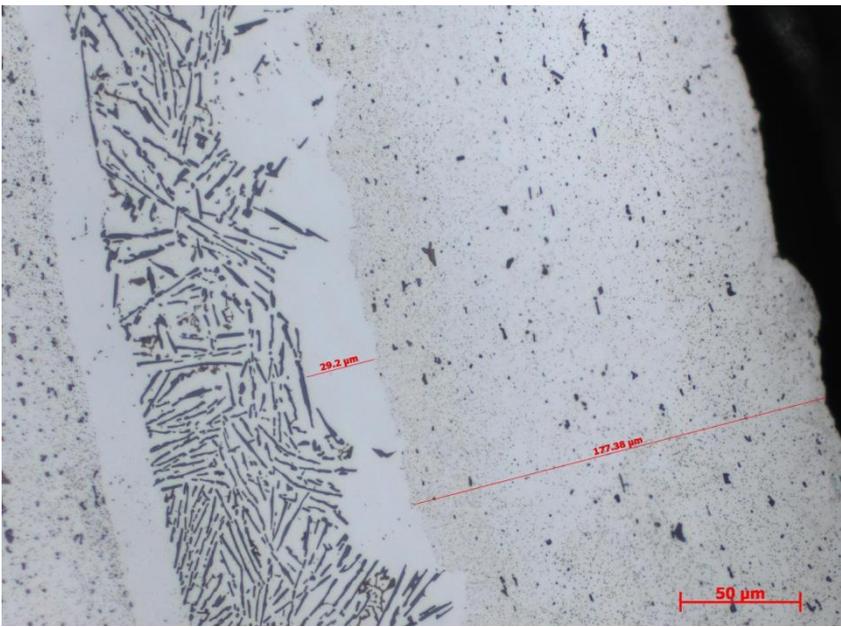
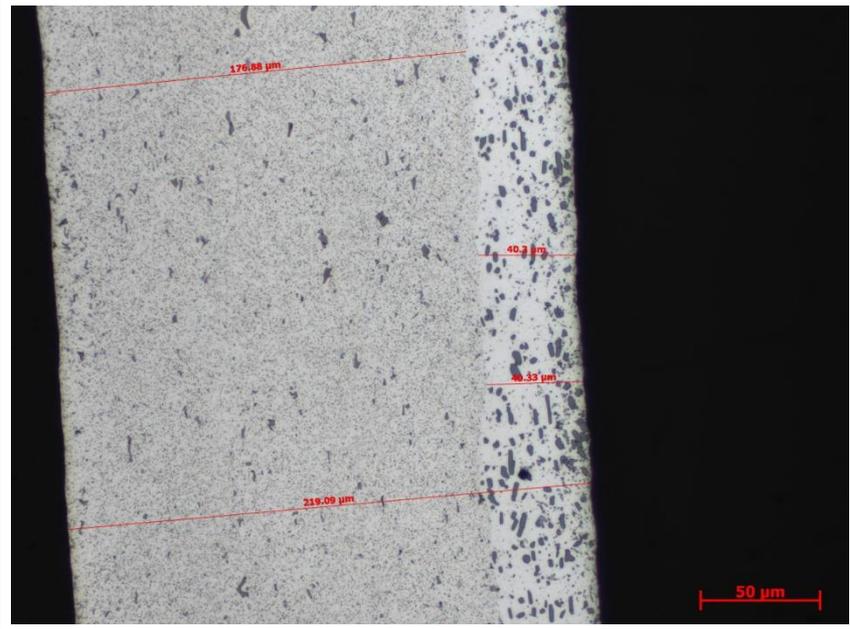
高级金属漆





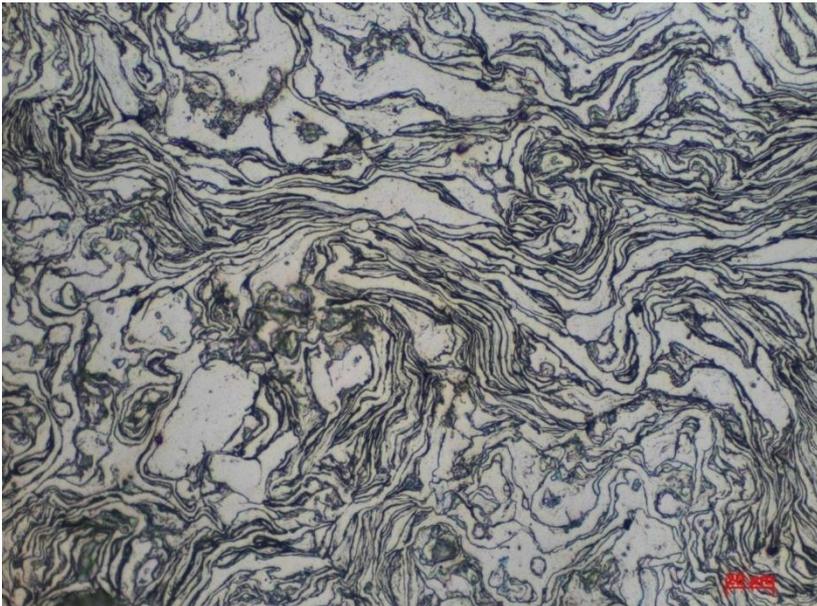
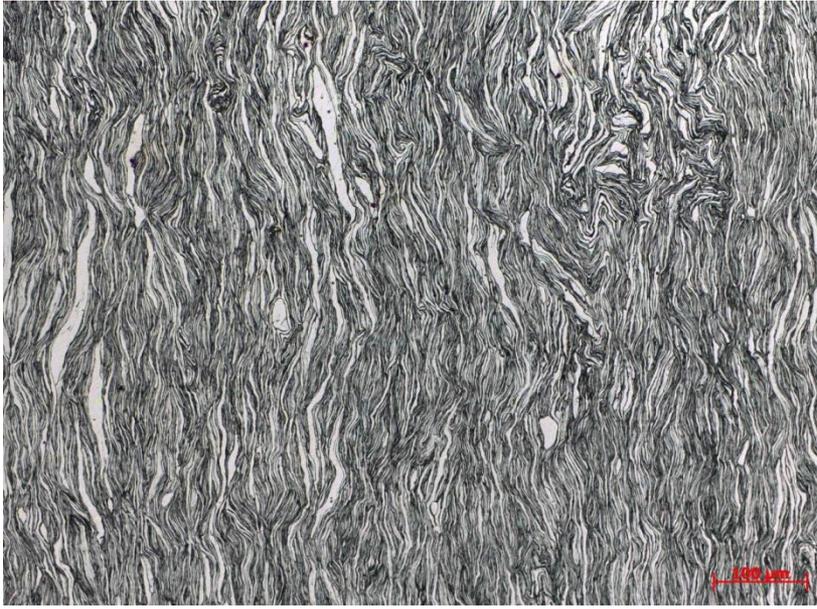
标准的低碳钢焊接接头组织





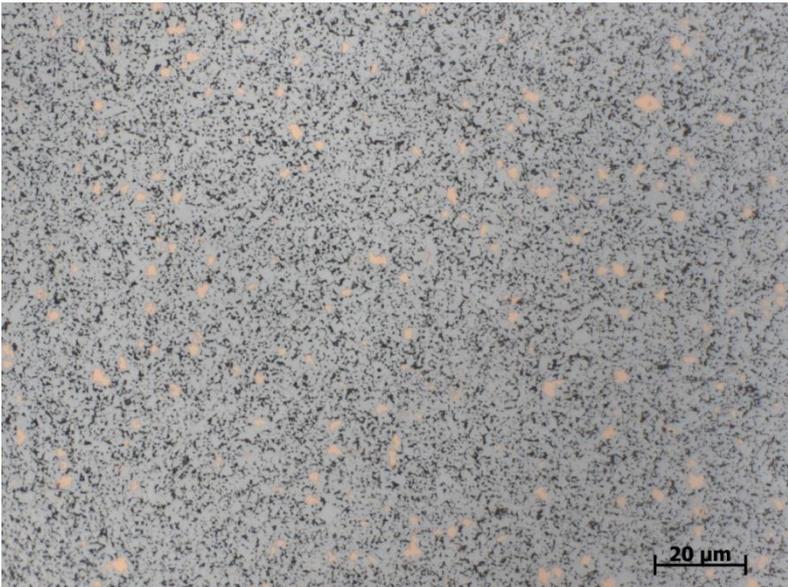
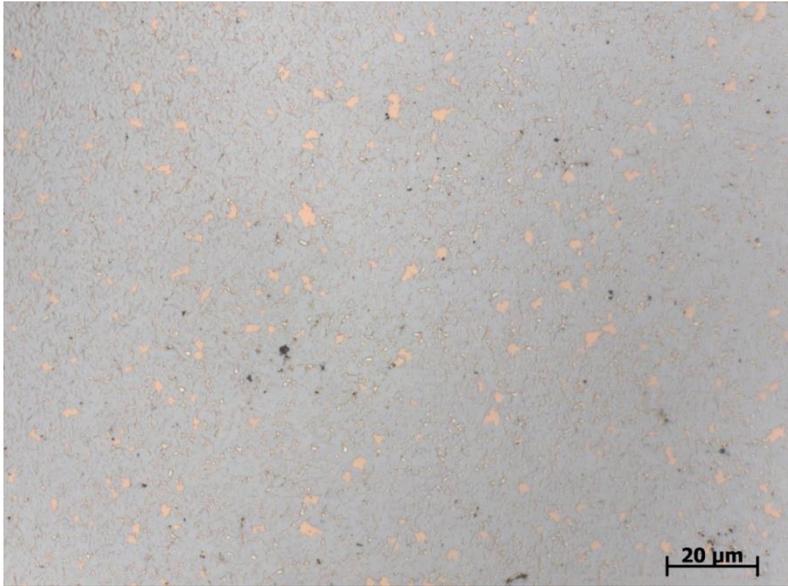
铝合金散热片 复合，钎焊





铝基复合材料





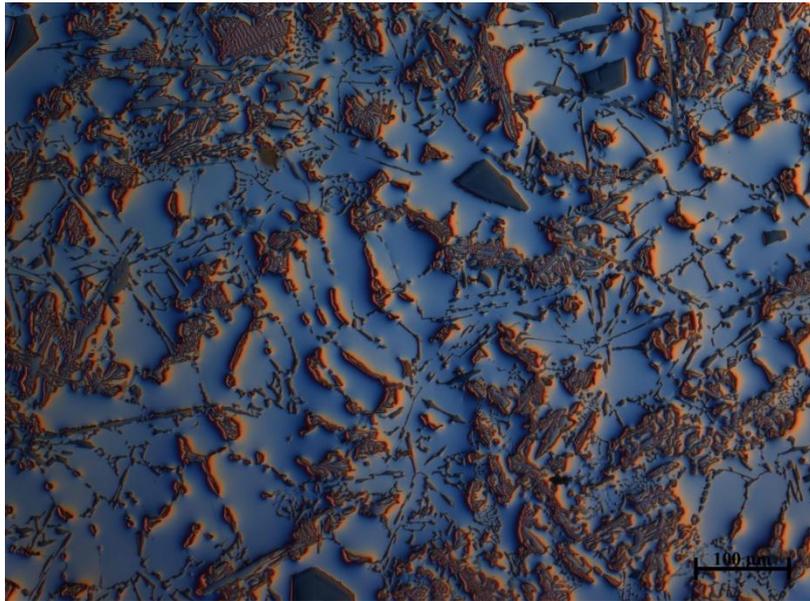
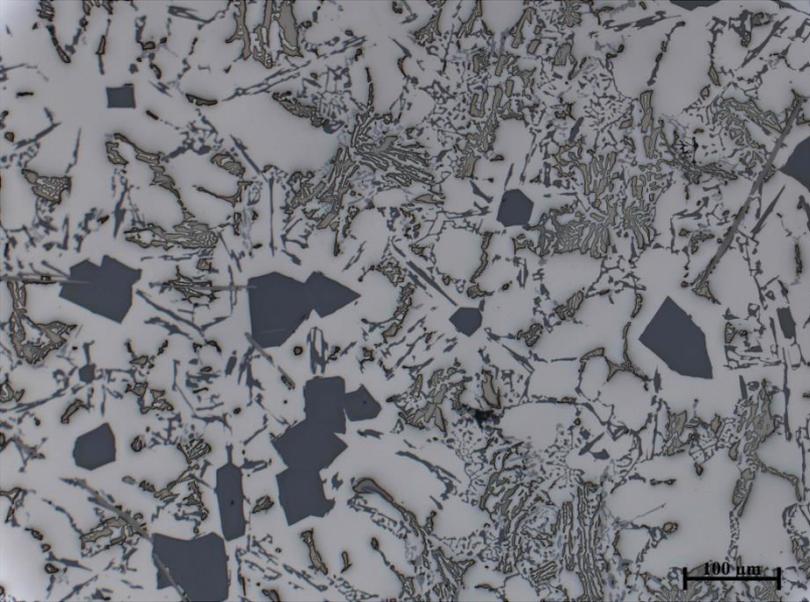
DIC组织显示凹凸反差
硬质合金



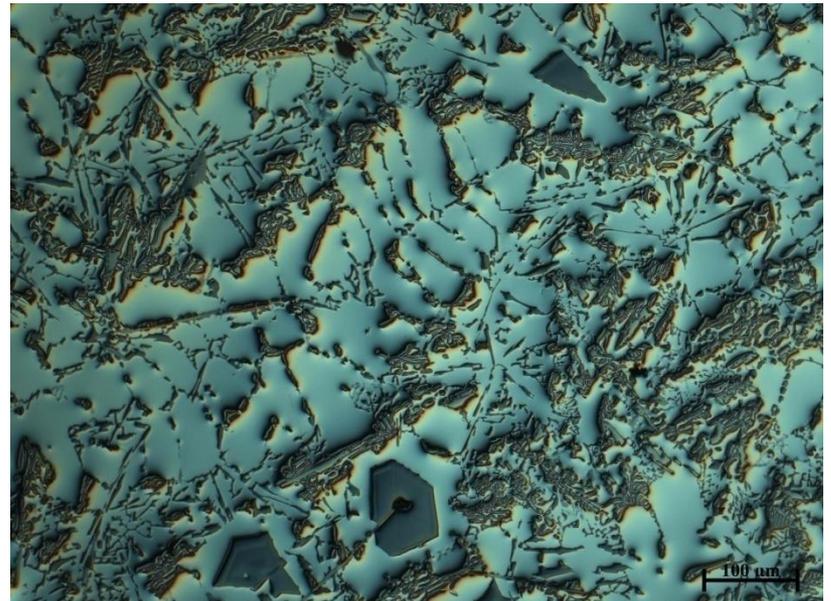


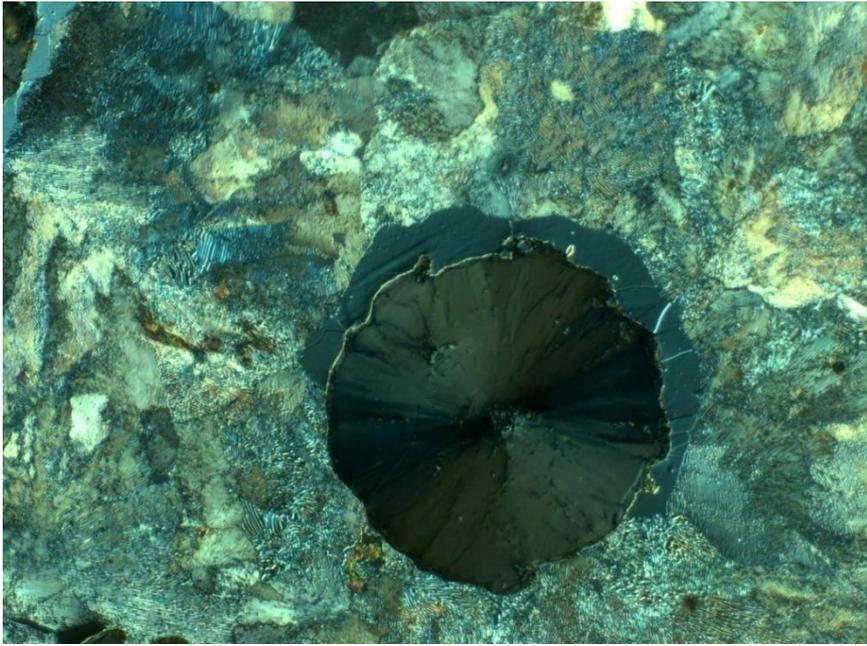
硬质合金





Al-Si铸造合金

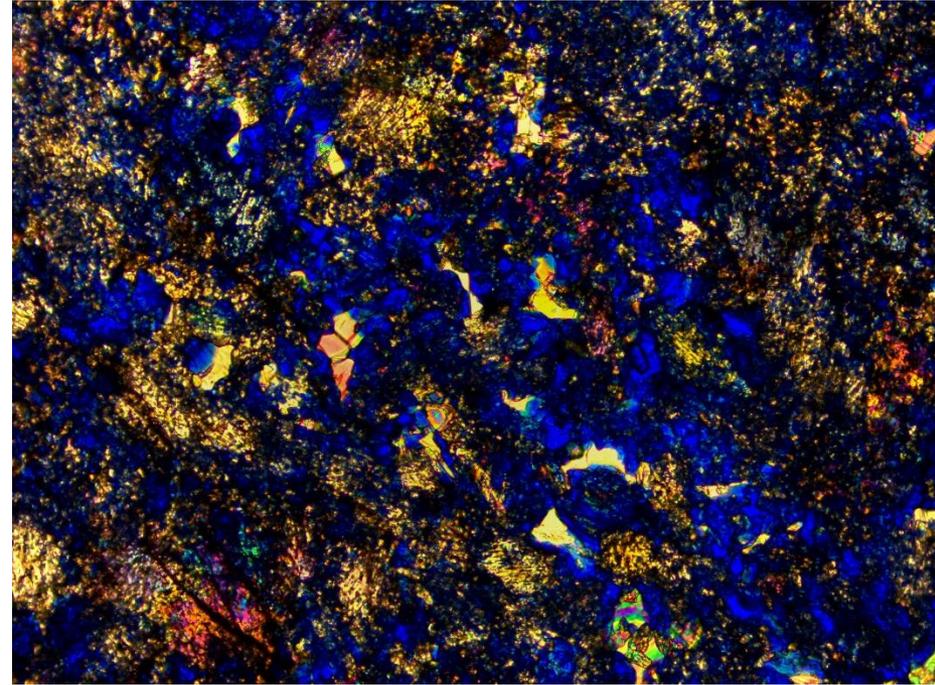
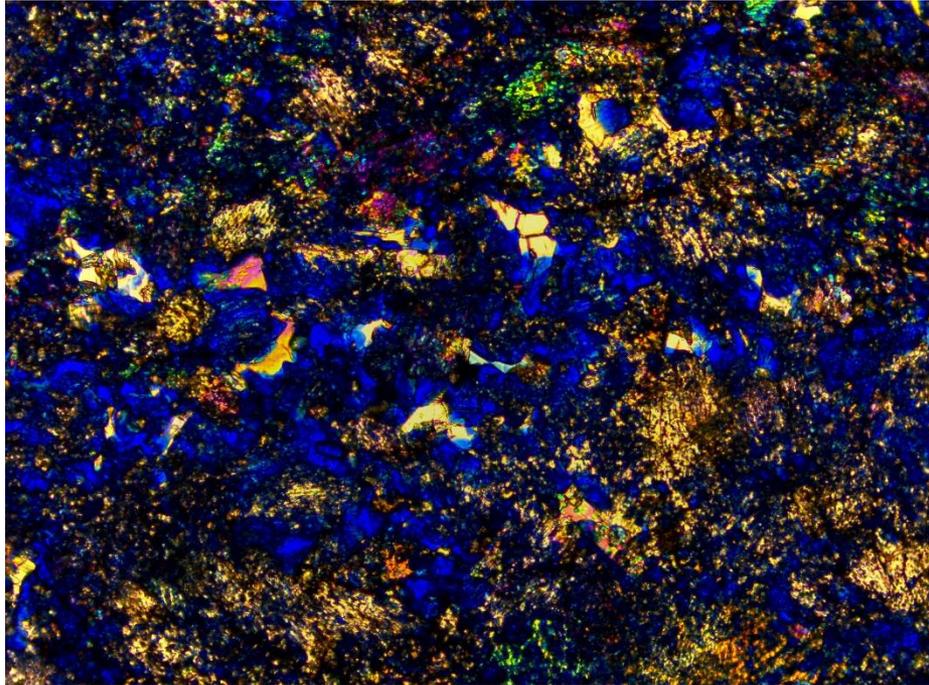




球墨铸铁的DIC观察



矿物，岩相



青金石，偏光显微镜



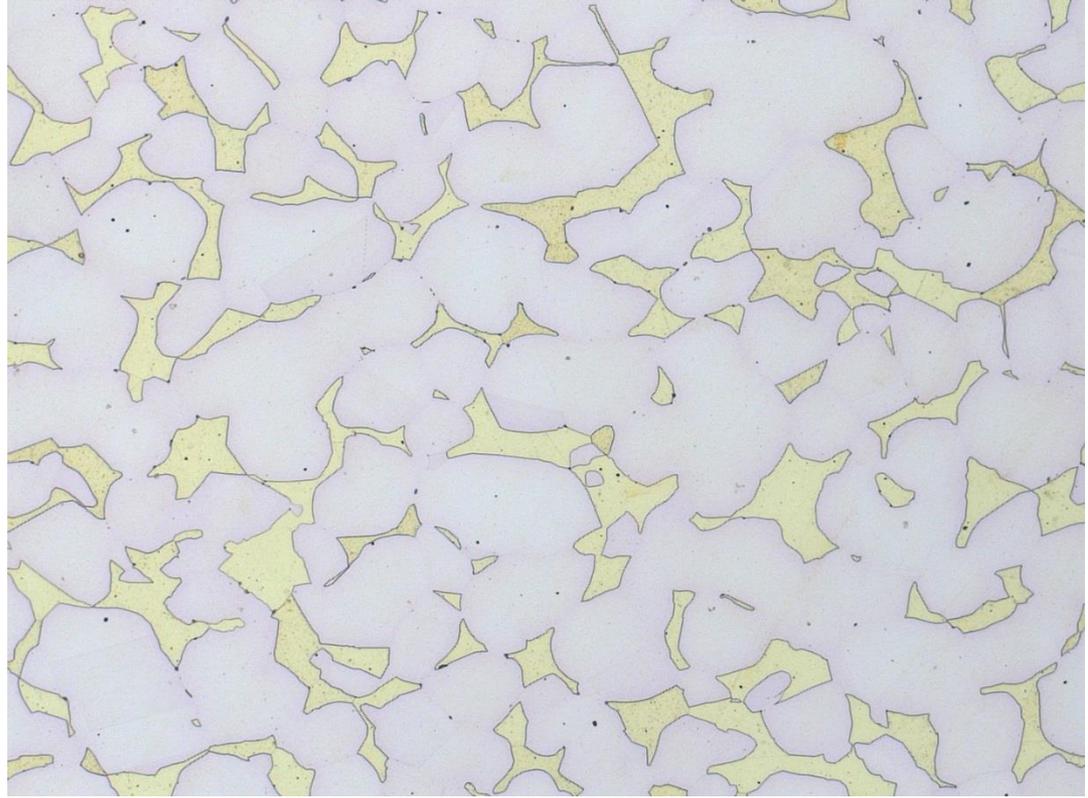
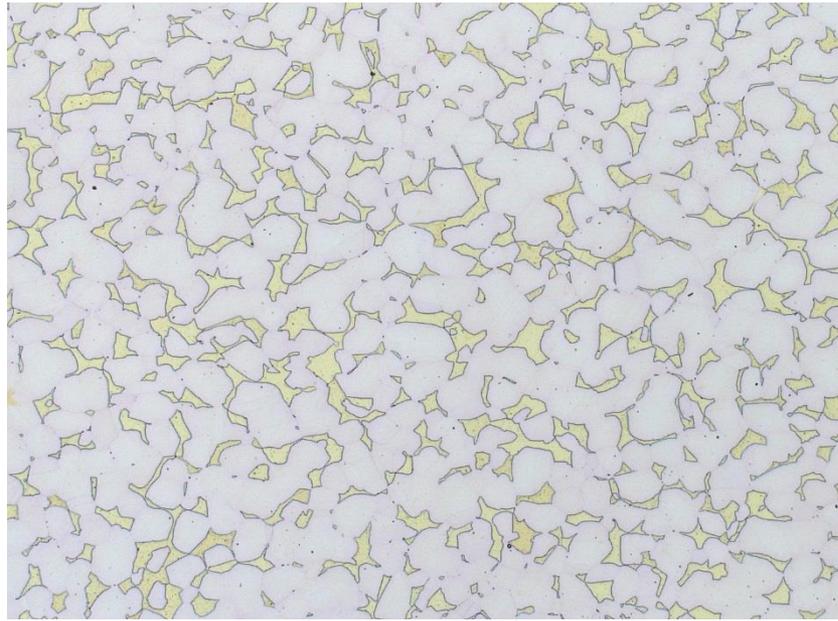
某公司标样之一



纯铜，退火态



某公司标样之一



H62黄铜，铸态



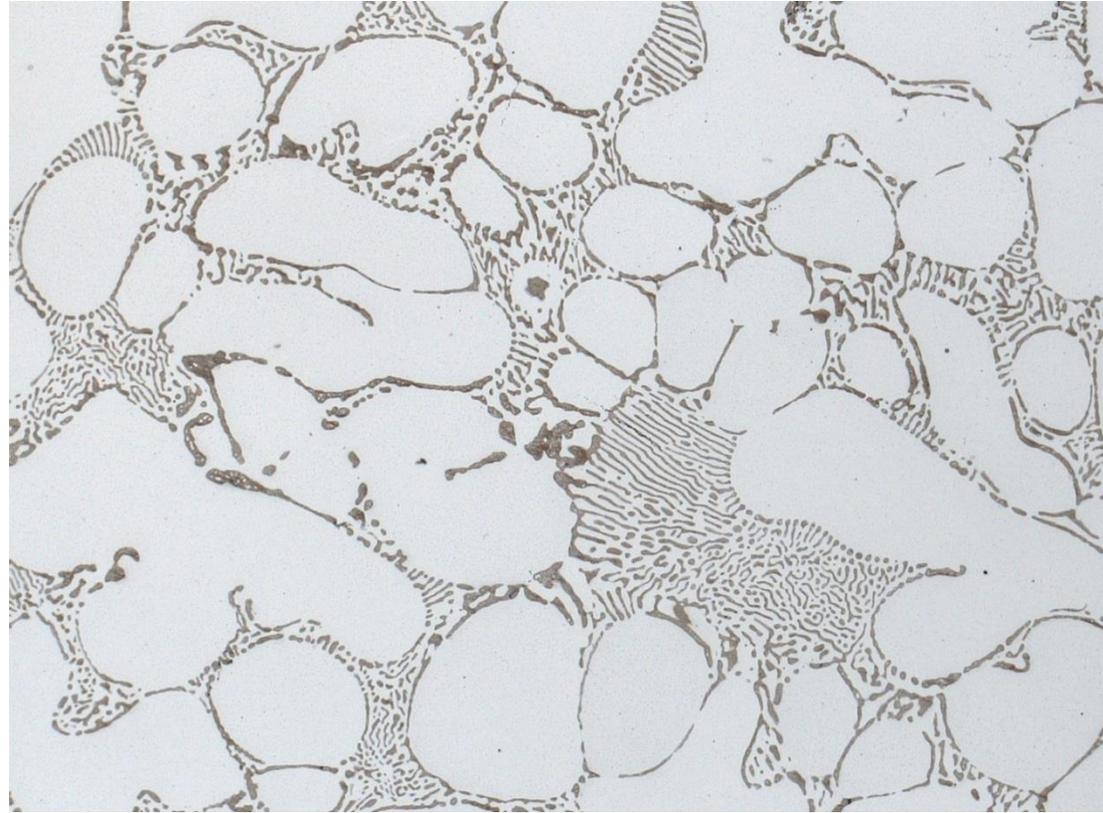
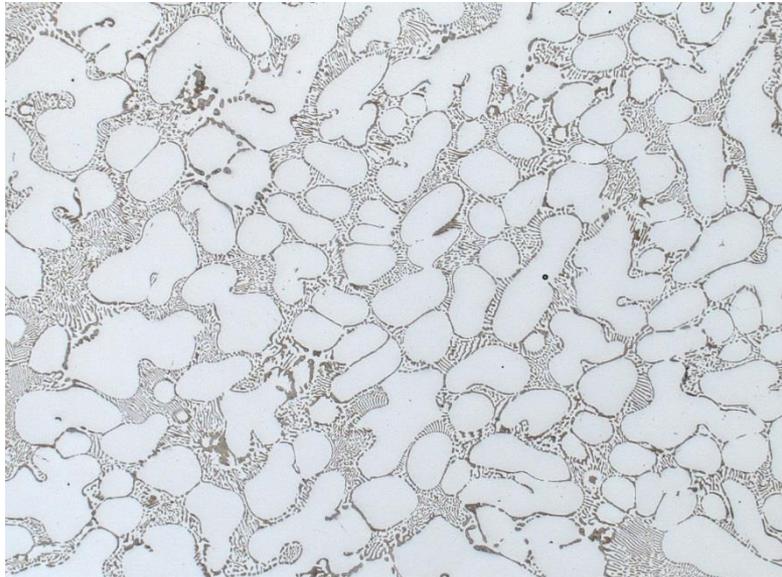
某公司标样之一



ZL102, 铸态



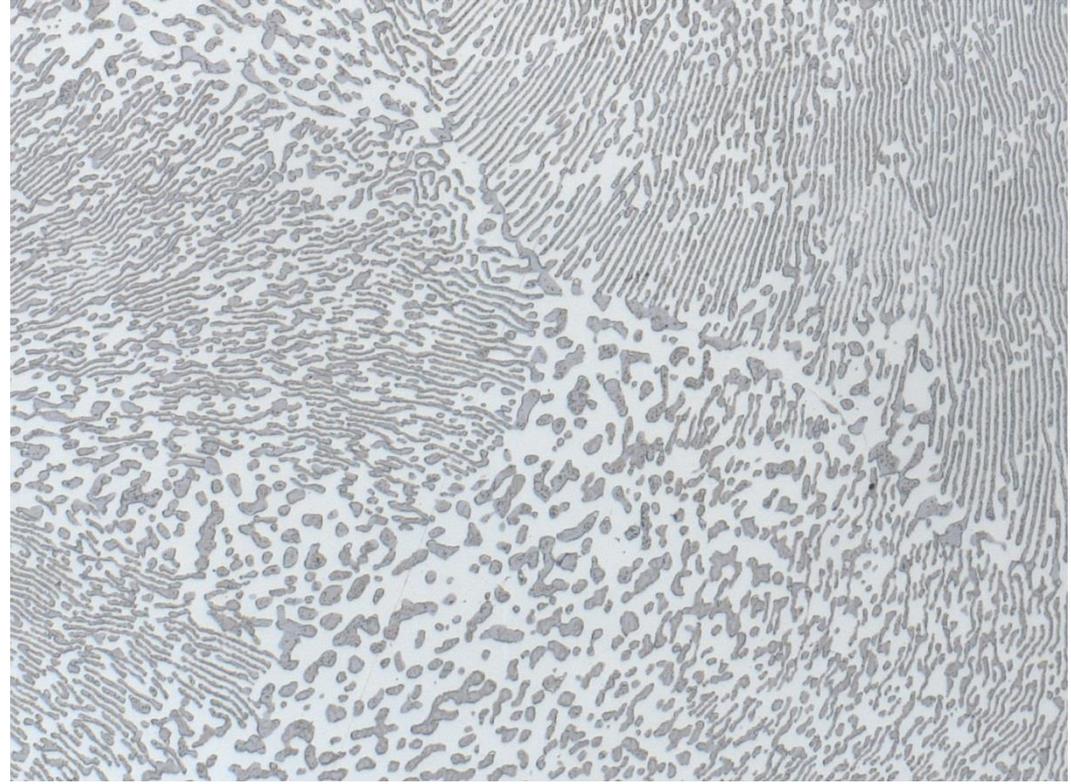
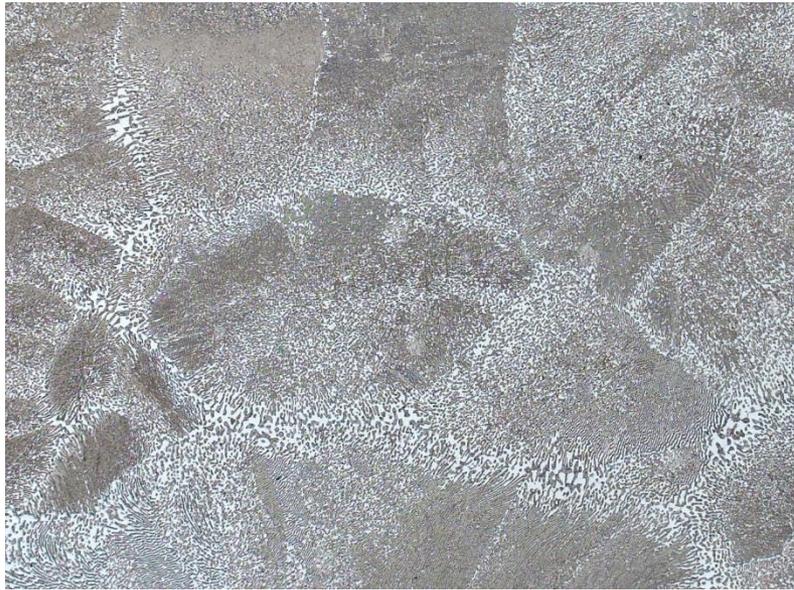
某公司标样之一



ZL102, 变质处理



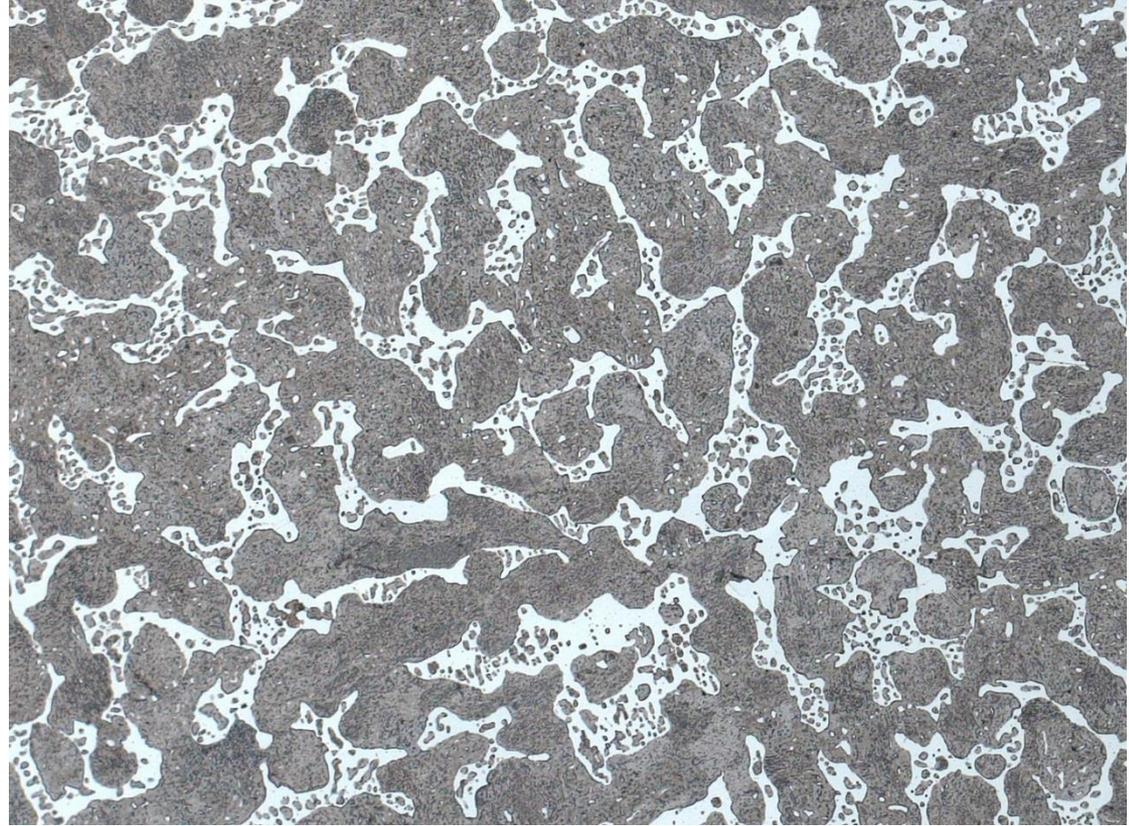
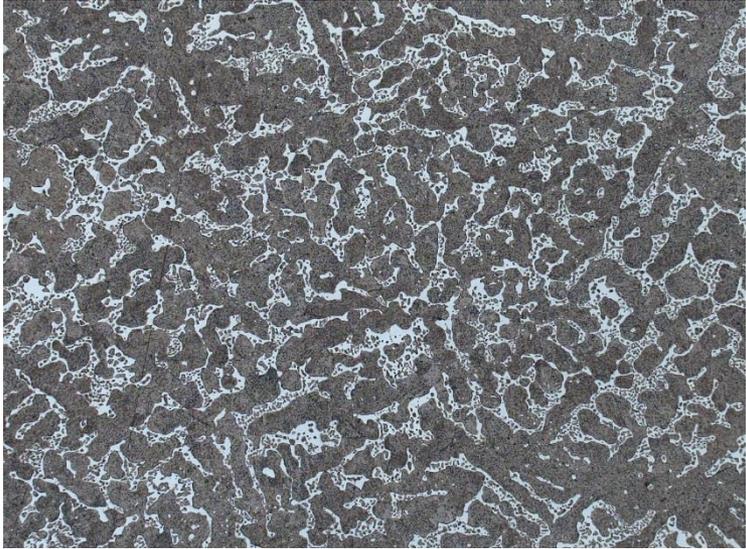
某公司标样之一



Pb-Sn共晶，铸态



某公司标样之一



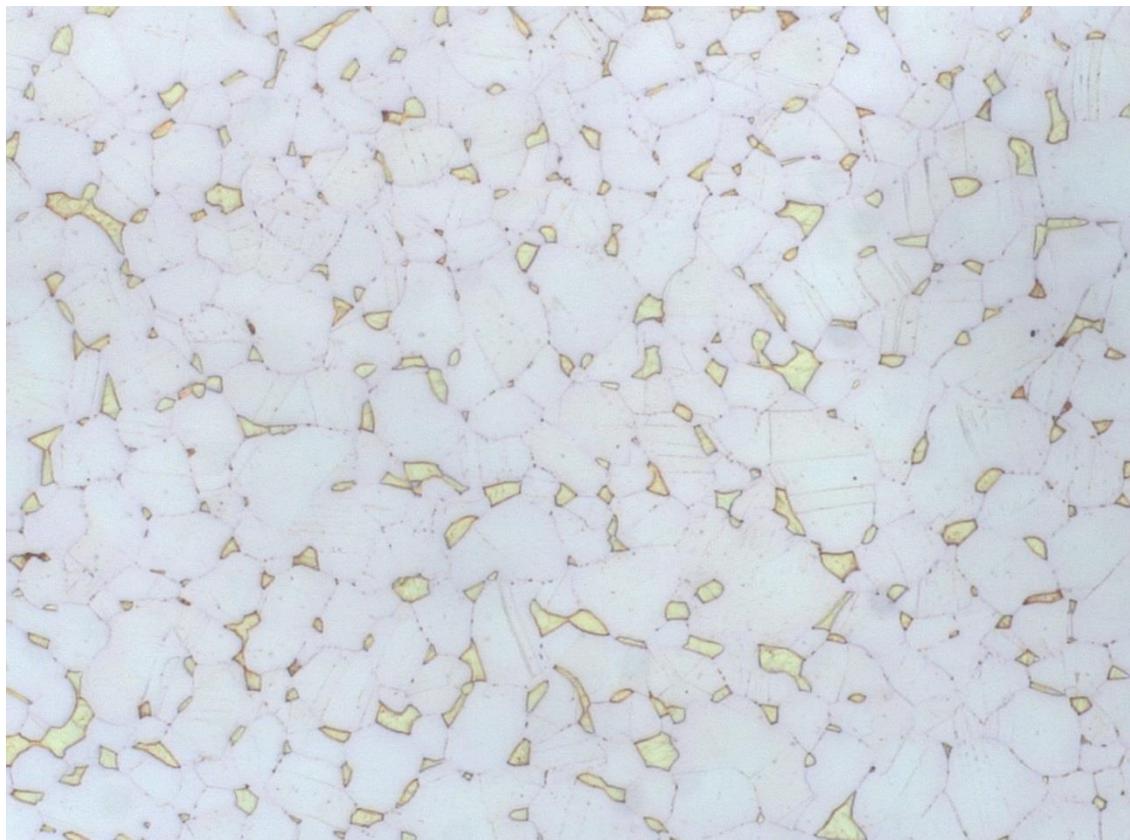
Pb-Sn亚共晶，铸态



以下是另外一家公司标样



H62黄铜，退火态



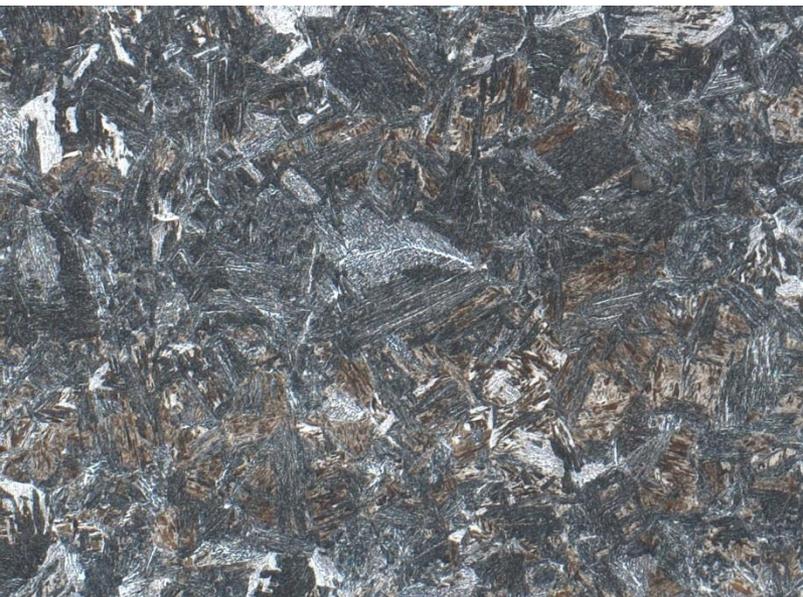
震动抛光后， α 孪晶出现





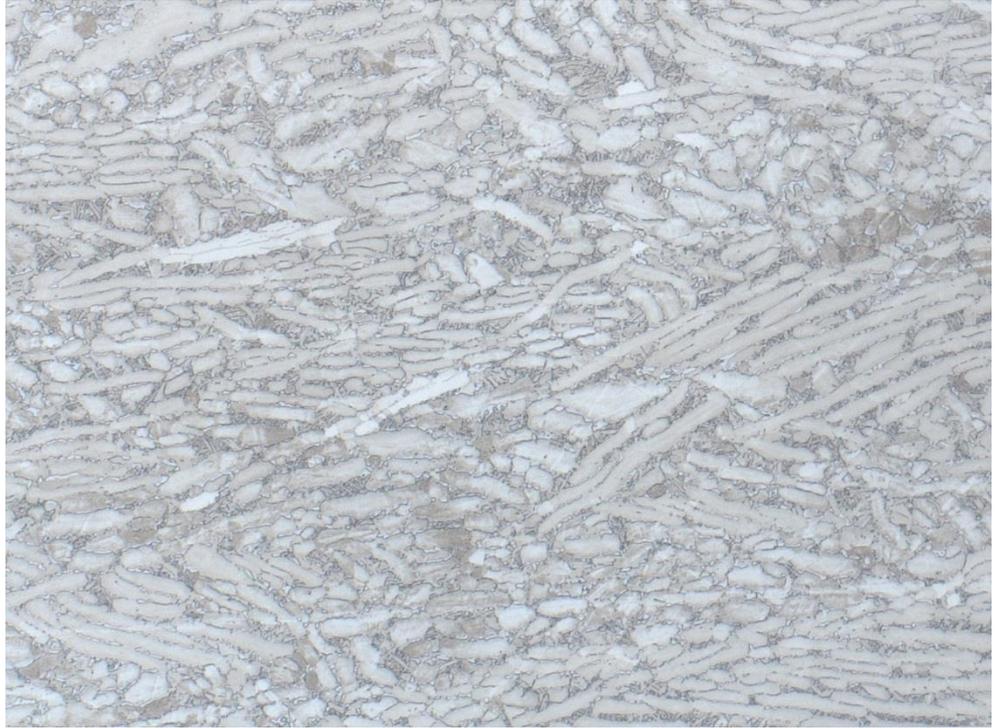
H70黄铜，变形退火





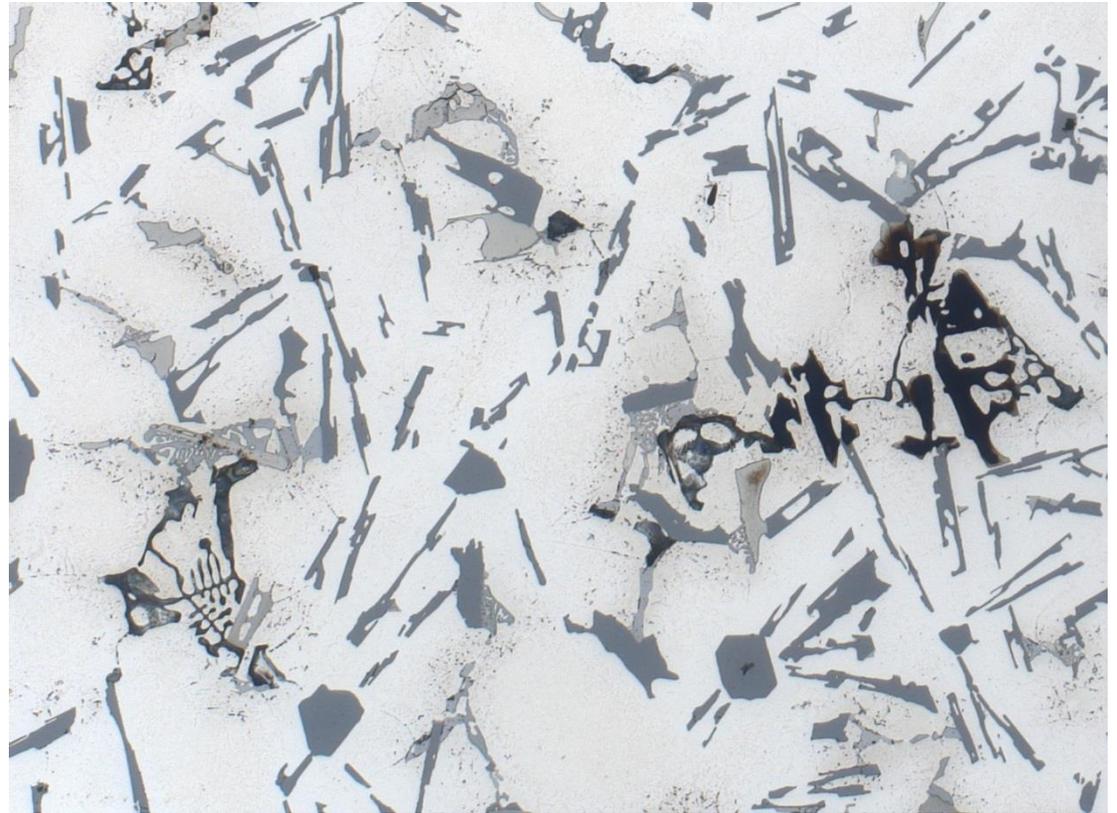
T8 上贝氏体





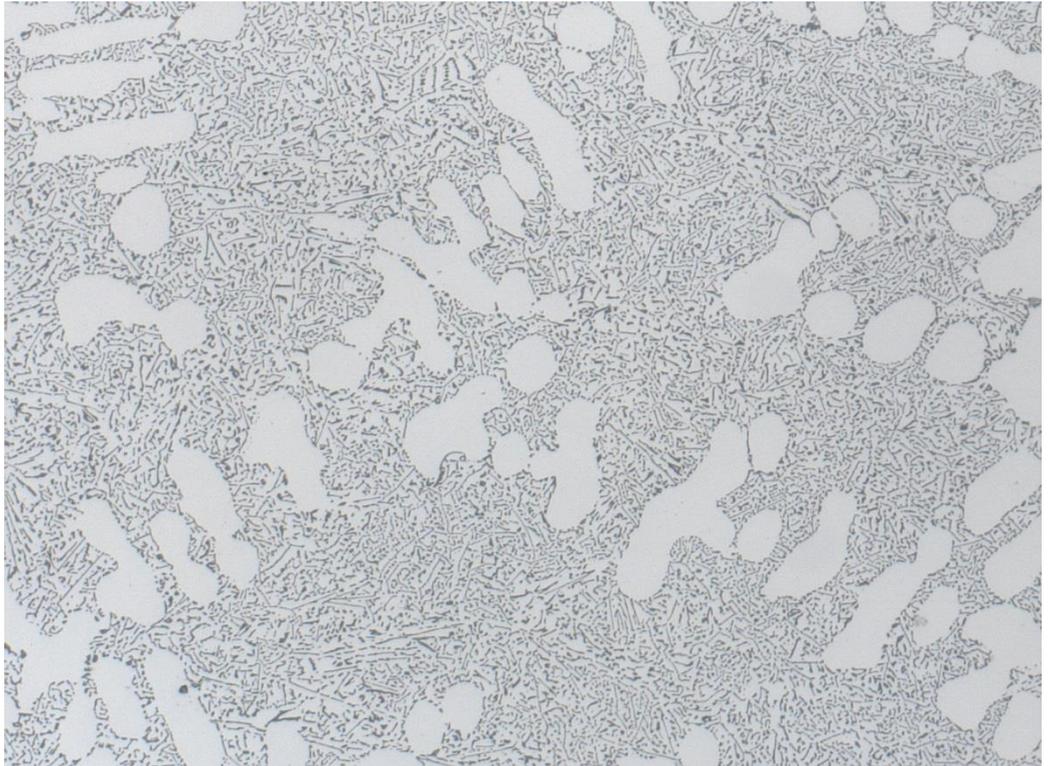
TC4，震动抛光前后





ZL102，铸态，有铁相和初晶硅





ZL102, 正常变质处理



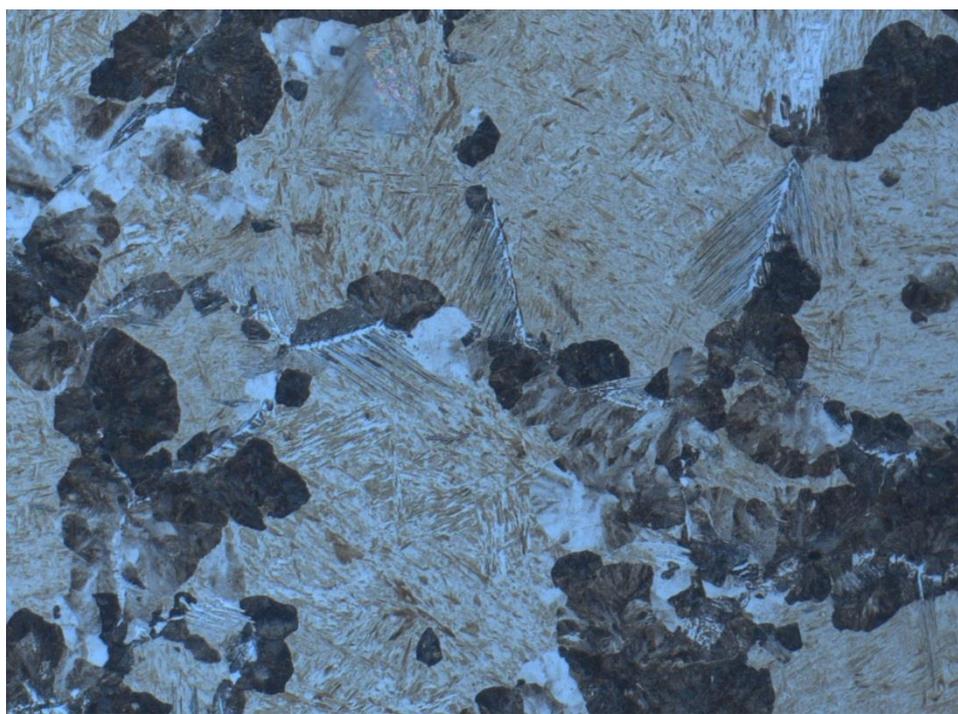


上贝氏体

下贝氏体

标样图片



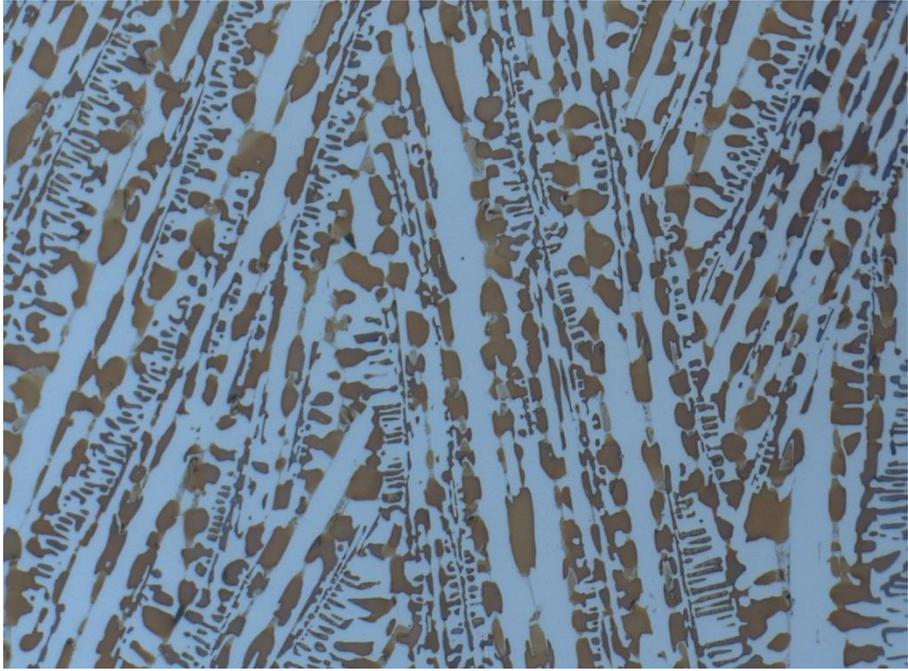


上贝氏体

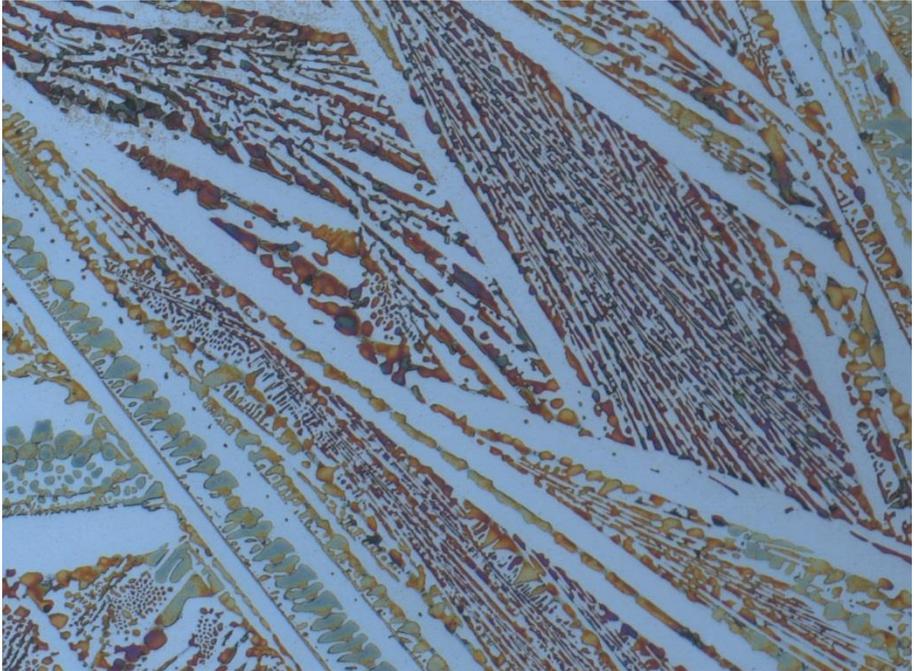
下贝氏体

金相图片





共晶莱氏体



一次渗碳体+莱氏体

标样图片



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