Alüminyum Test Eğitim ve Araştırma Merkezi

Mart 2017

SEM Nedir?

SEM ile Neler Yapılabilir?

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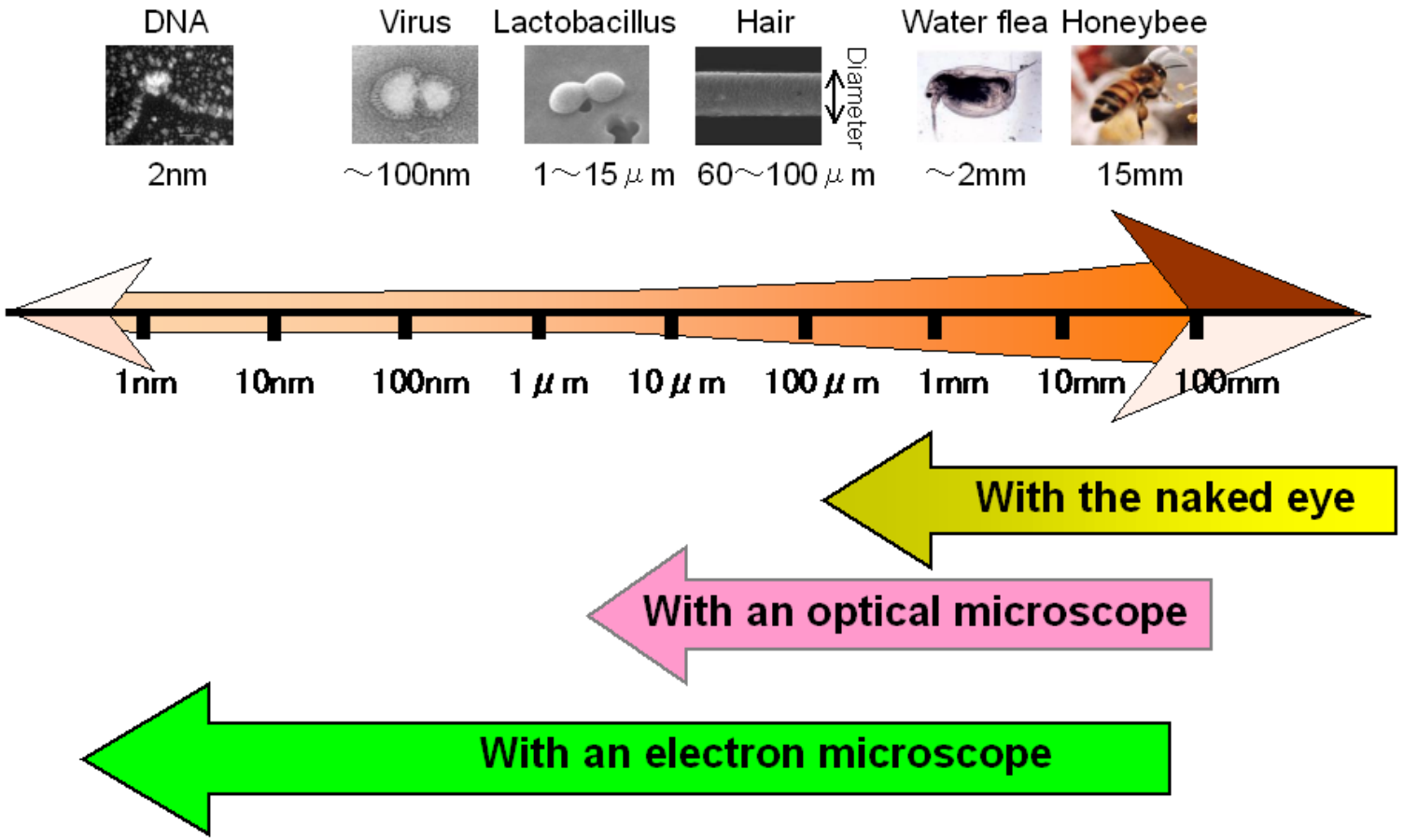
SEM ile Neler Yapılabilir?



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SEM Giriş

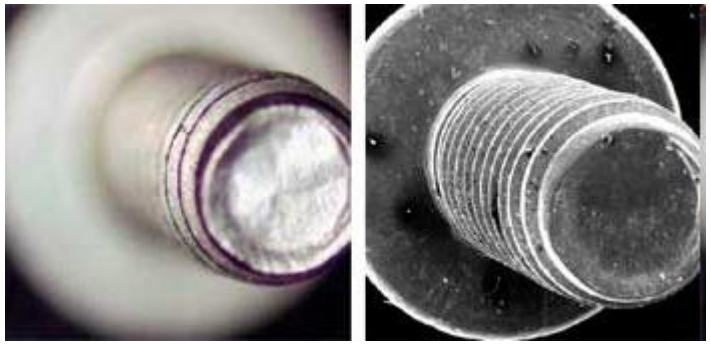
SEM nedir?

Mikro ve nano boyuttaki yapıları görüntüleyebilmek için kullanılan bir mikroskop türüdür.

- Yüksek ayırt edebilme gücü
- Yüksek alan derinliği

} "Büyük" ve "pürüzlü" örnekler, toz halindeki örnekler.

Optik Mikroskop - SEM



Vida Uzunluğu: ~ 0.6 cm

- Topografi, morfoloji ve kimyasal analiz

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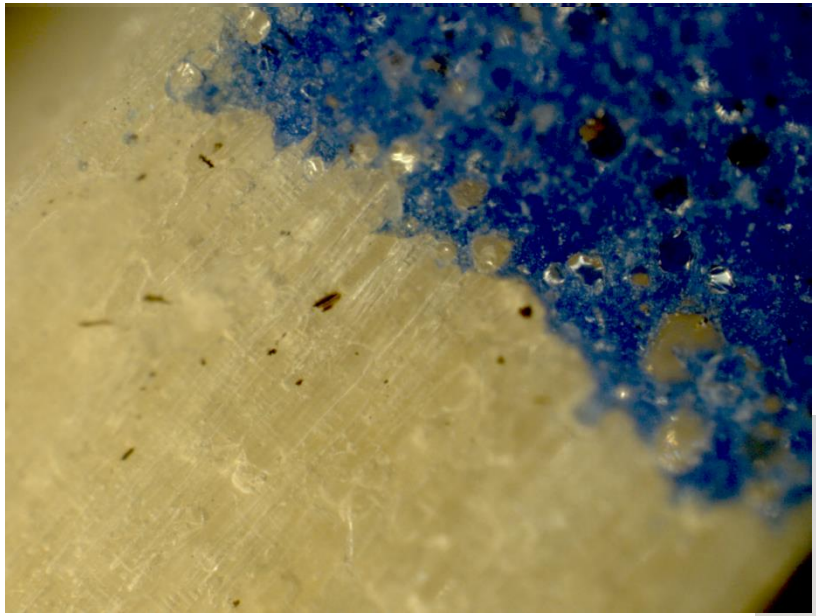
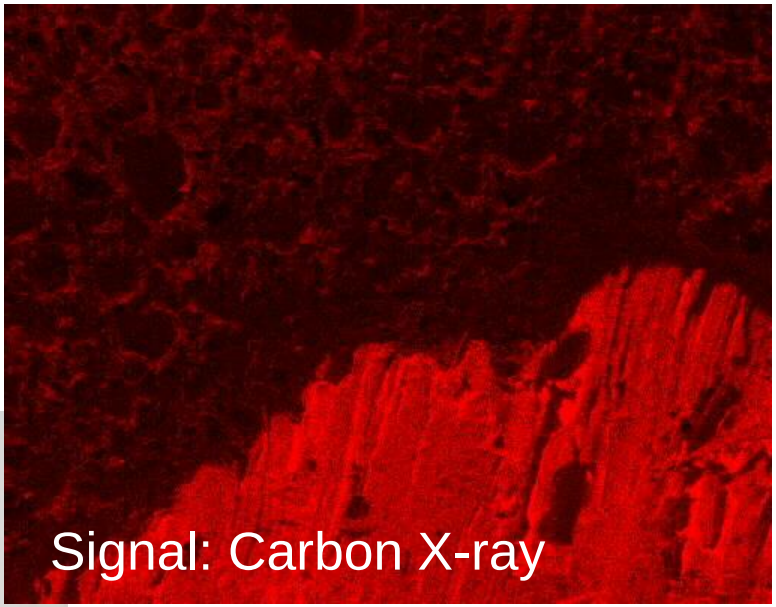
Daha iyi alan derinliği





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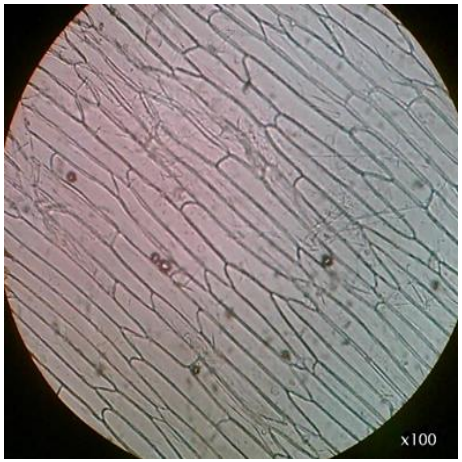
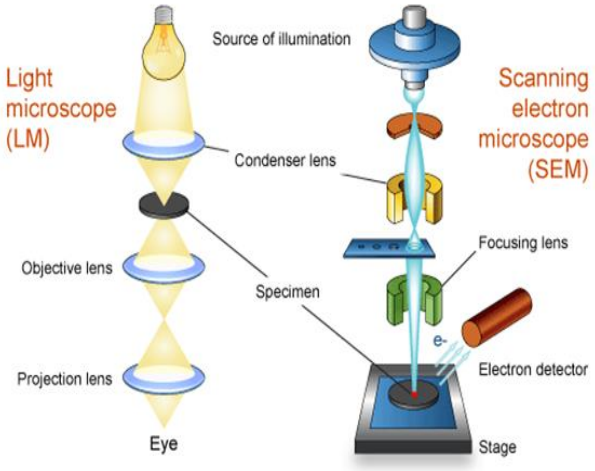
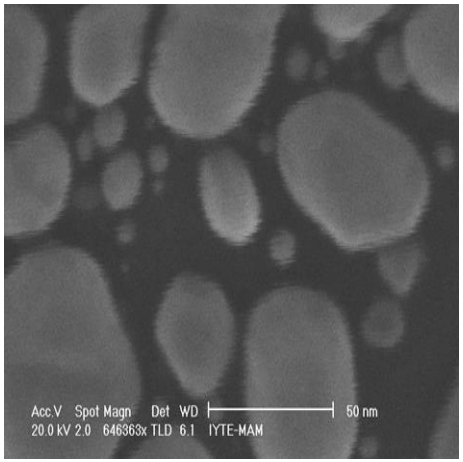
Optik Mikroskop Karşılaştırma





$$r = \frac{0.61\lambda}{\mu \sin \alpha}$$



Optik Mikroskop	Elektron Mikroskobu
λ = 400 –780 nm	**λ = 0.00698 –0.0867 nm**
μ ≥ 1	μ = 1 (vacuum)
max. r = 150 nm	for λ = 0.00698 nm and α = 0.1 radians r = 0.04 nm

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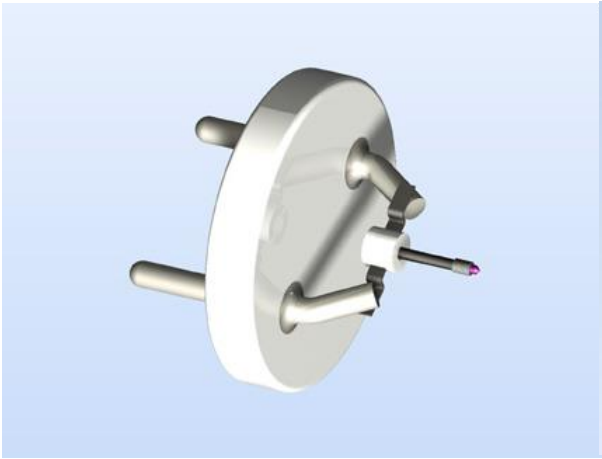
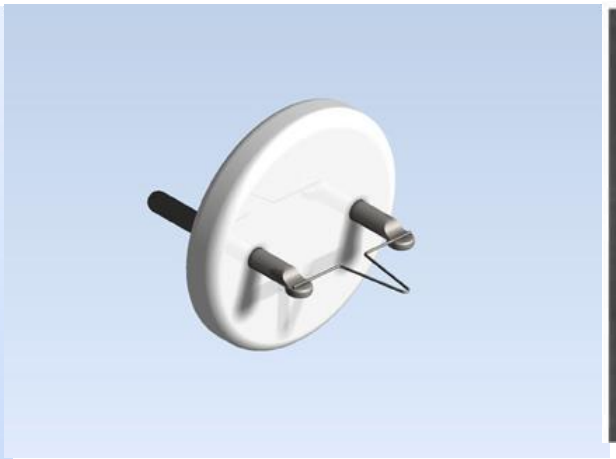
Elektron Kaynakları

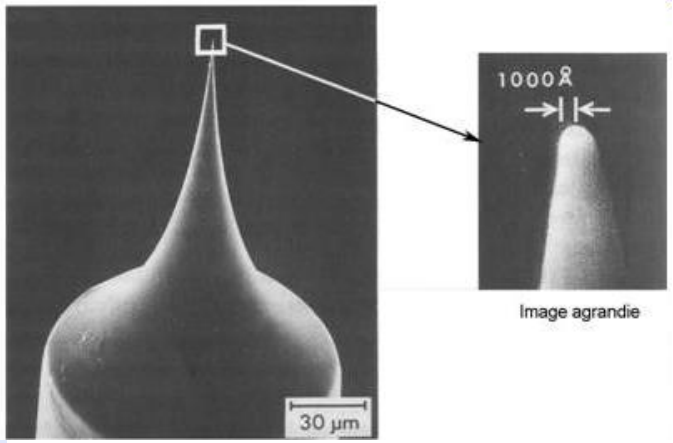
- Termoiyonik kaynaklar (Tungsten flament, LaB6, CeB6)
- Alan emisyonlu kaynaklar (Ekstra vakum ve soğutucu) yüksek akım yoğunlukları
  - Schottky Emitörleri
  - Soğuk Alan Emitörleri



LaB_6 Tek kristal



Tungsten flament



Alan emisyonlu kaynak

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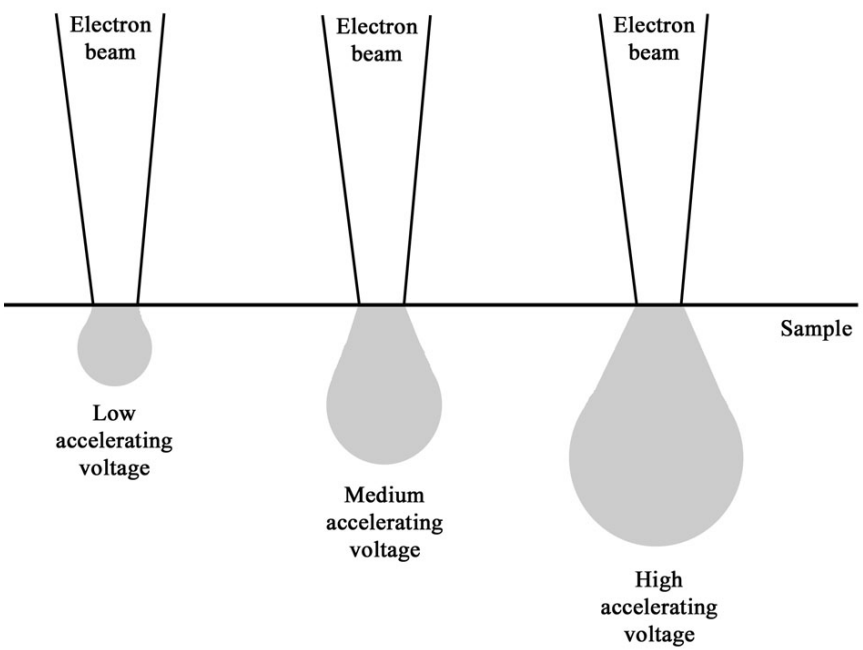
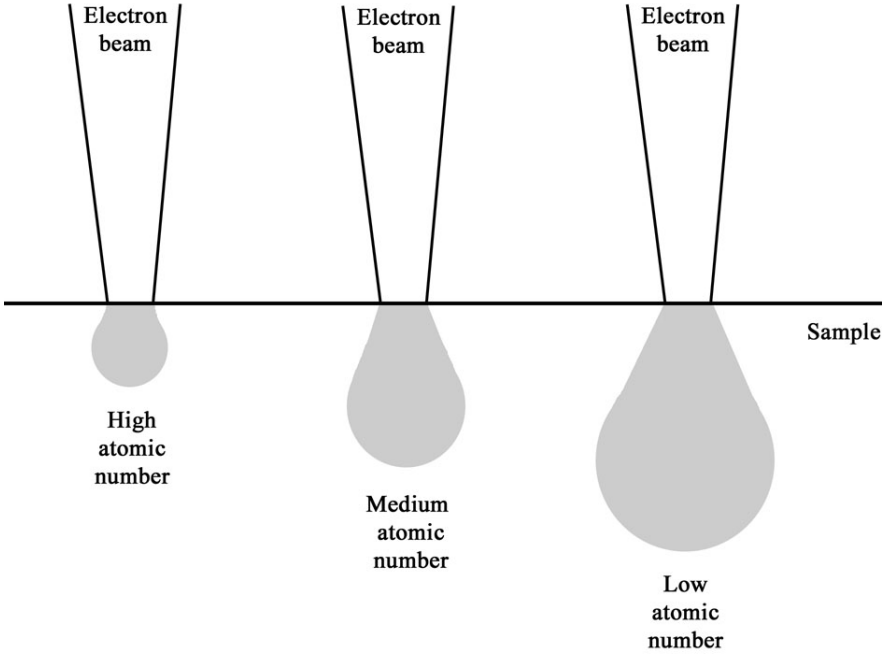
Elektron demeti ile örnek etkileşimi





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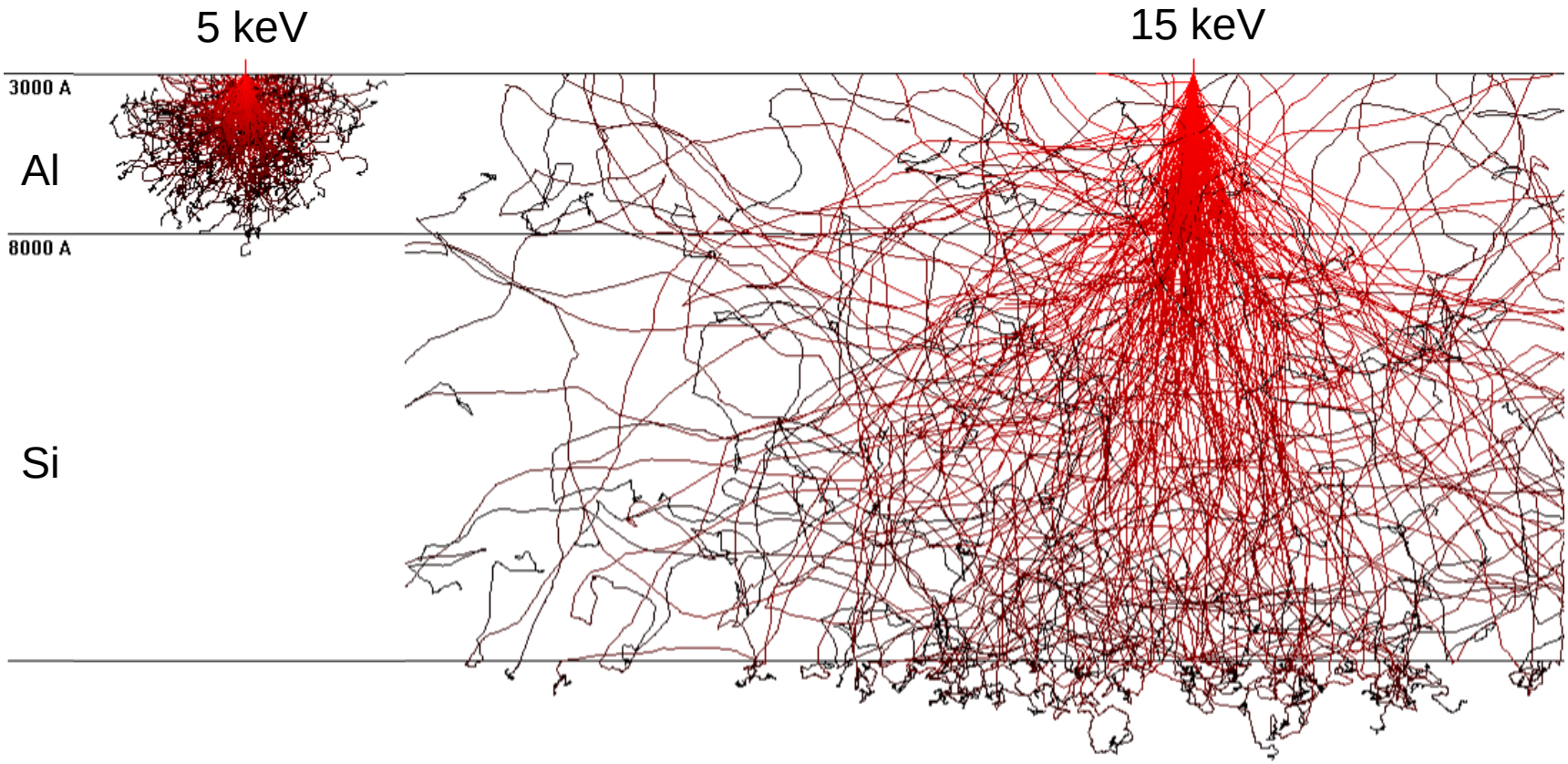
Elektron demeti ile örnek etkileşimi



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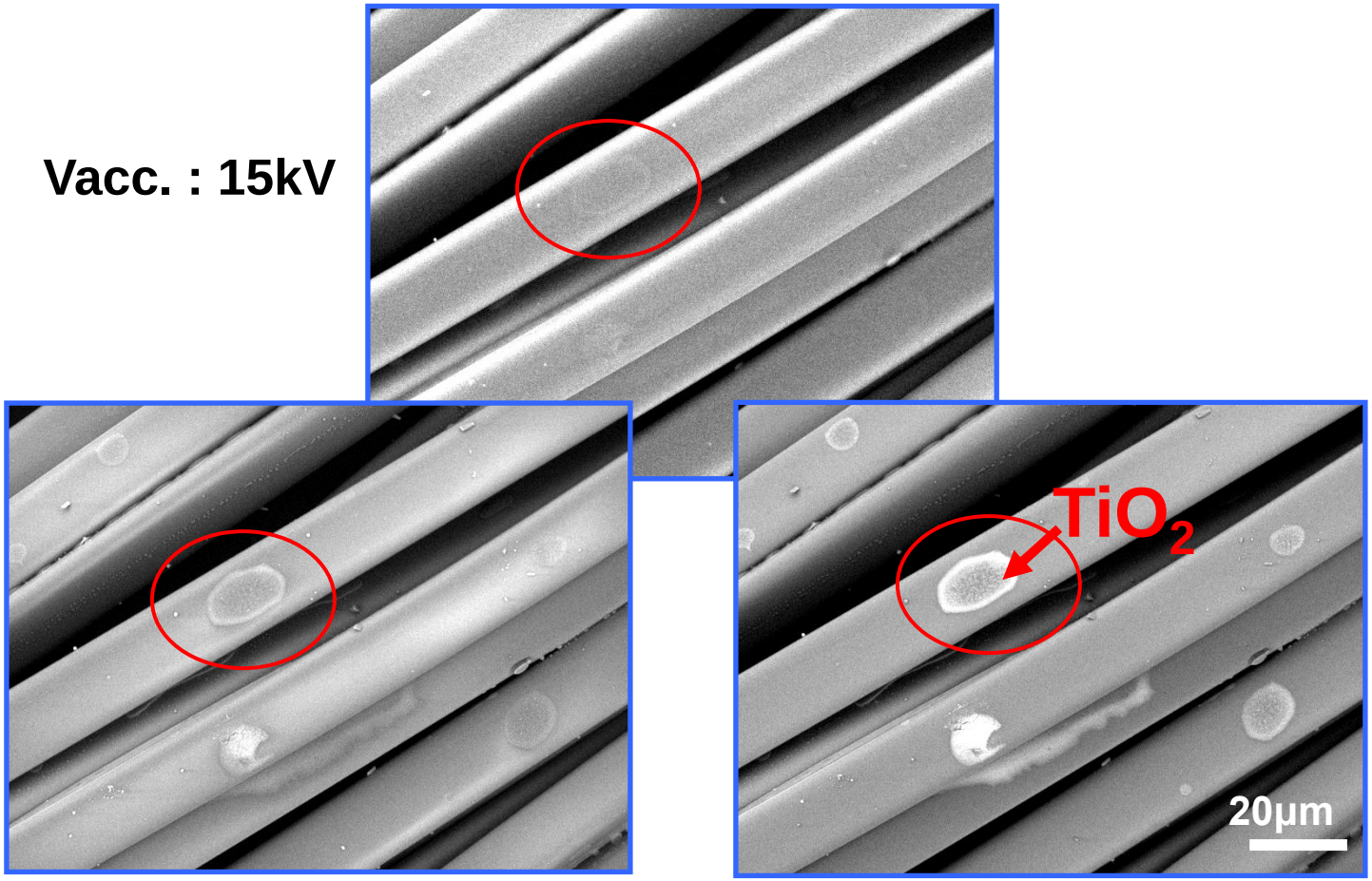
Elektron demeti ile örnek etkileşimi

Düşük Enerji ile yüzey detayları



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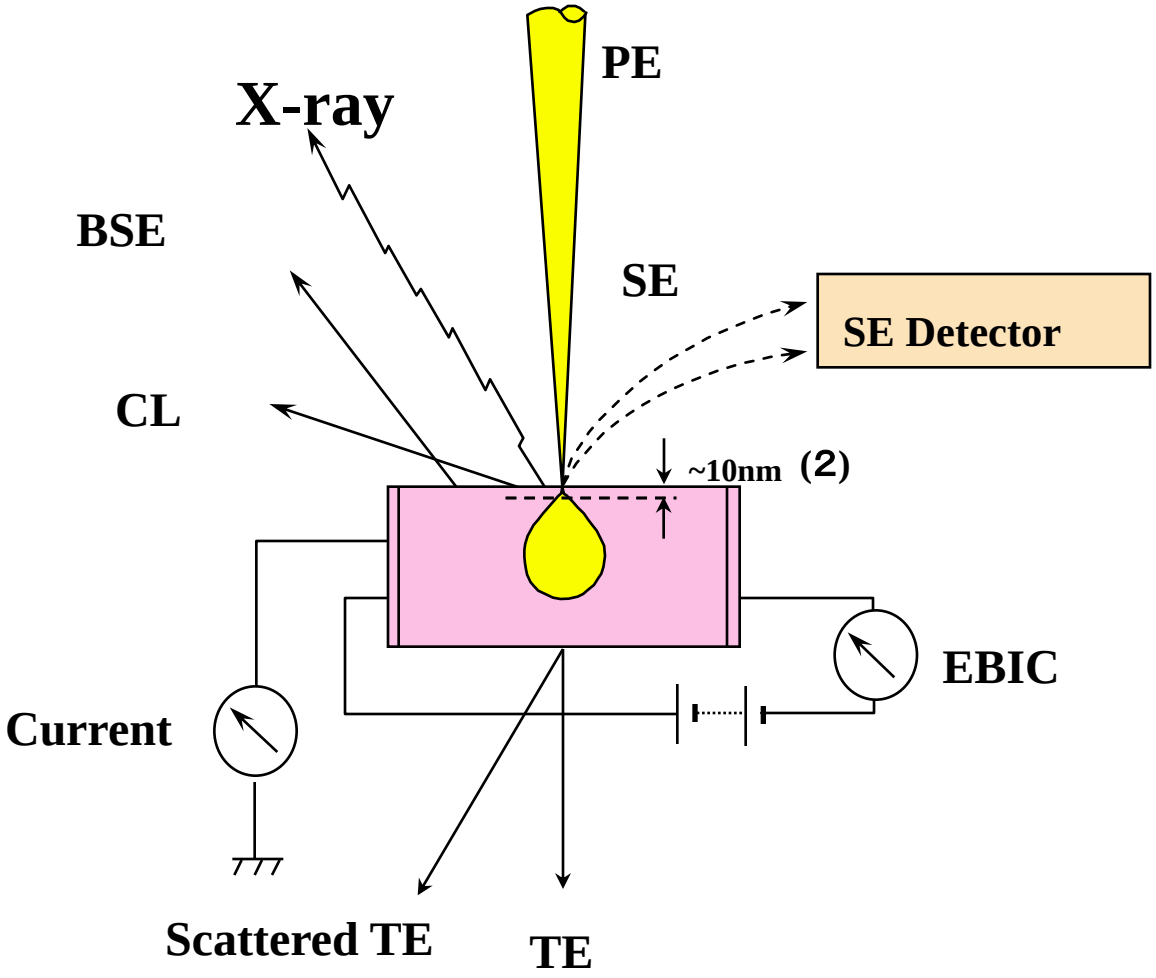
Elektron demeti ile örnek etkileşimi



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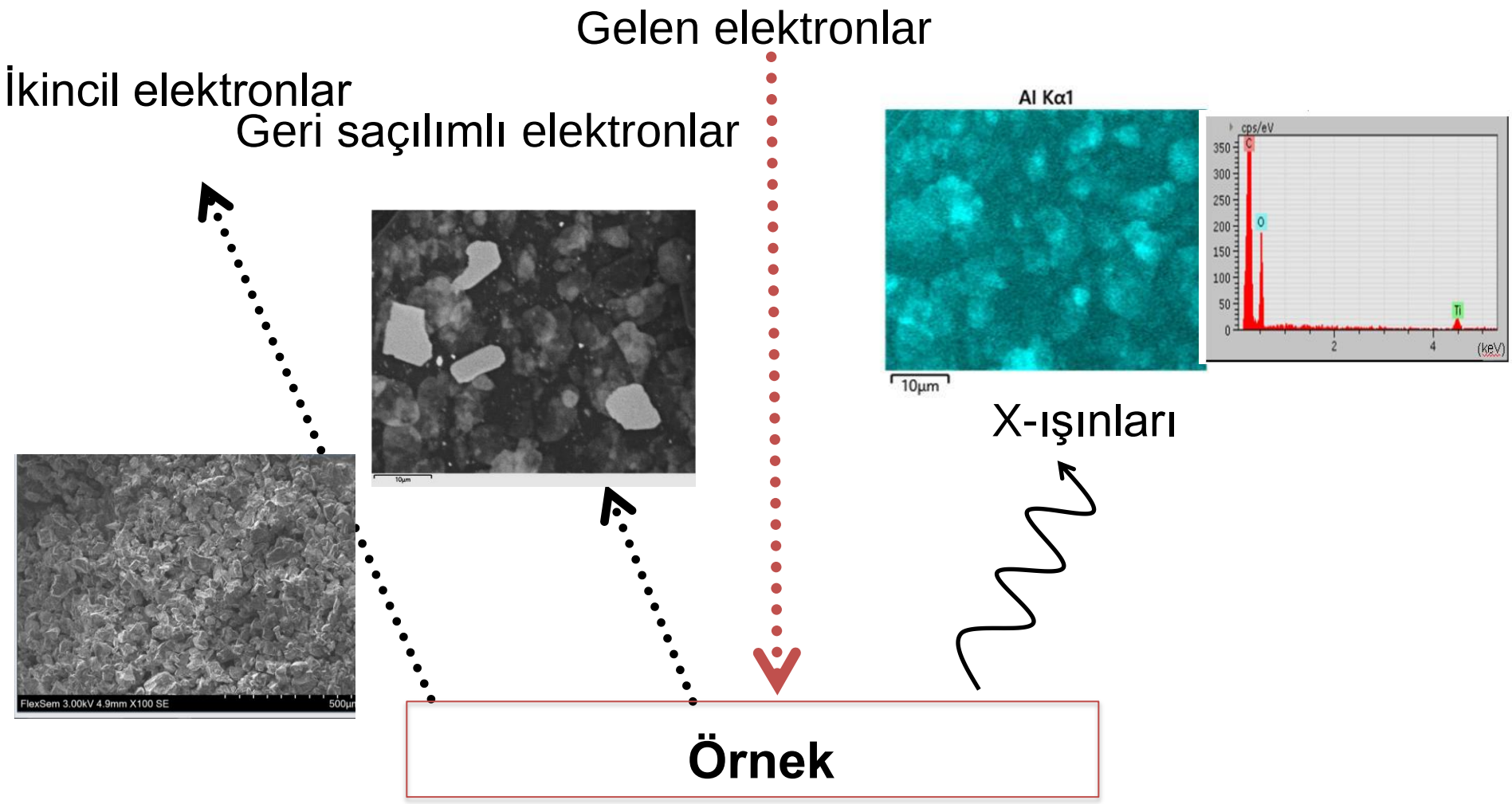
Elektron demeti ile örnek etkileşimi



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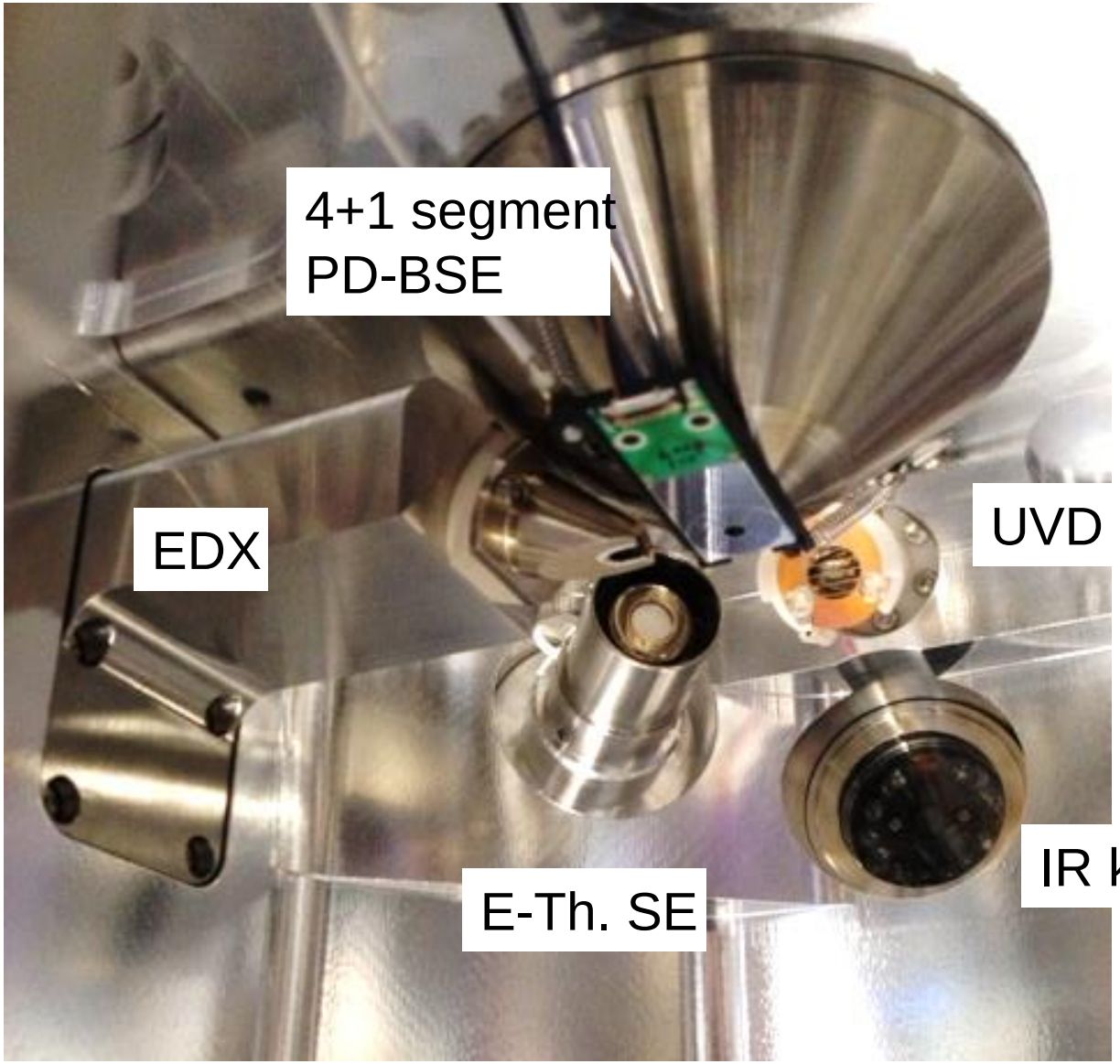
Dedektörler



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Detektör Sistemleri

- Everhart-Thornley Dedektörü (SE)
  - İkincil elektronları algılar
  - Sadece yüksek vakum modunda çalışır
- 4+1 segment PD-BSE detektor
  - Geri saçılımlı elektronları algılar
  - 5 segmentli olan dedektör 1.5kV den itibaren görüntü alabilir
  - Düşük vakum, yüksek vakum modlarında çalışır
- Ultra Variable pressure mode Detector (UVD)
  - Düşük vakum modu için foton bazlı SE detektör
  - Düşük vakumdaki soft örneklerin görüntülenmesi

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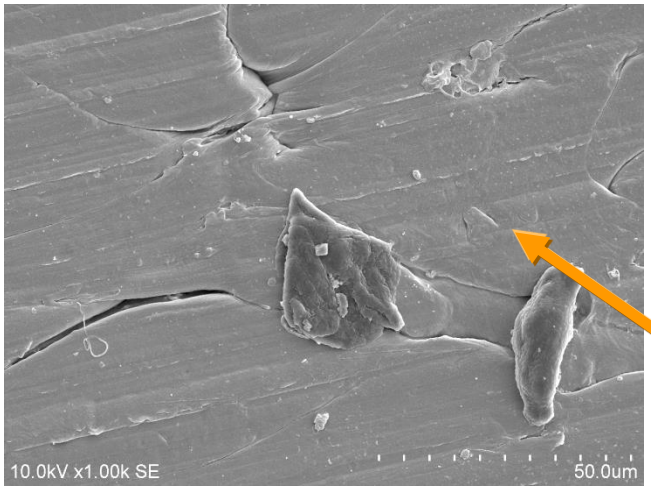
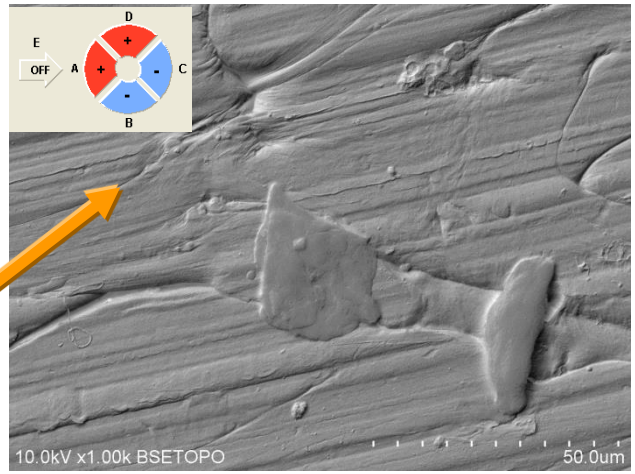
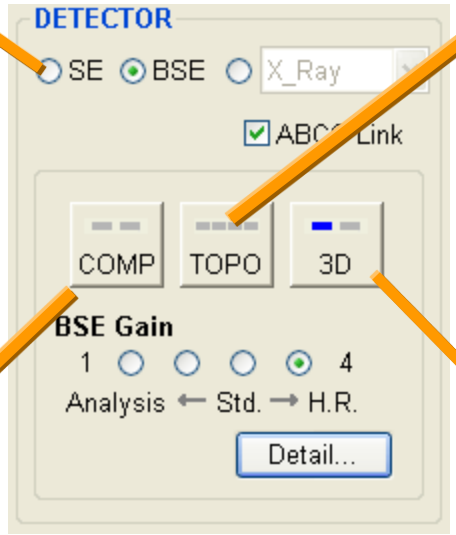
BSE Detektörü

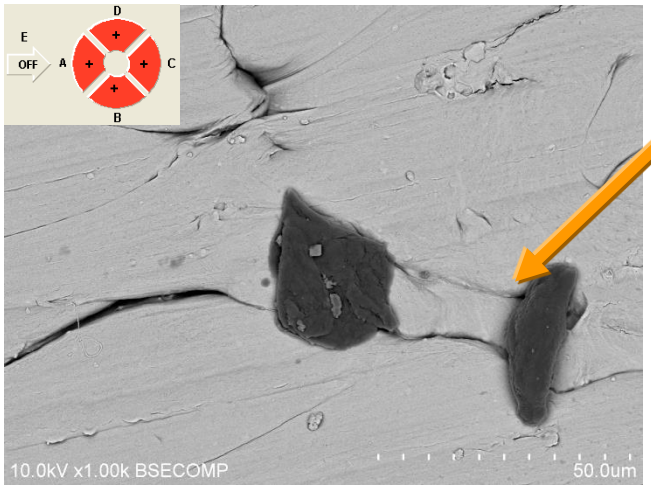
SE
(Everhart Thornley)



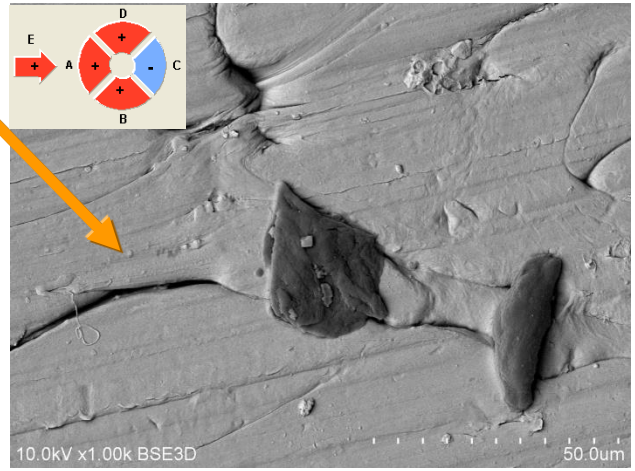
BSE TOPO







BSE COMPO



BSE 3D

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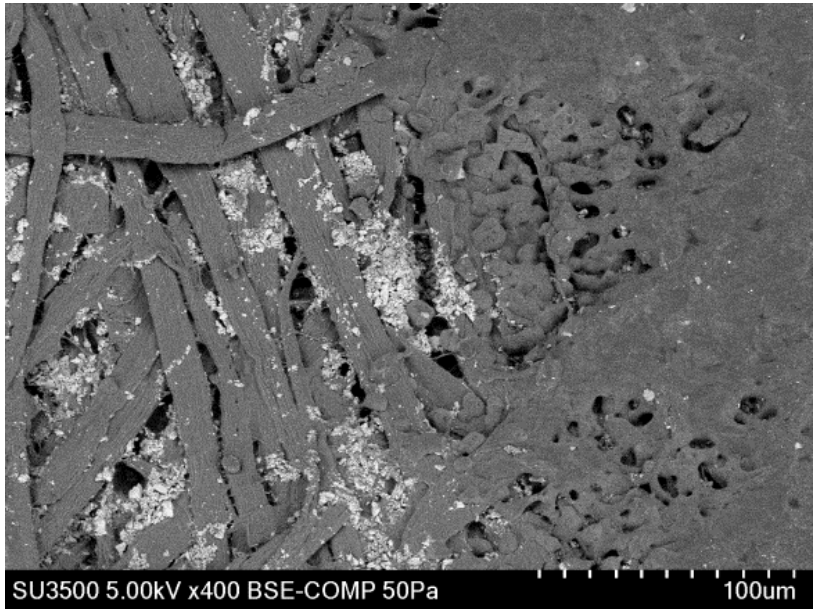
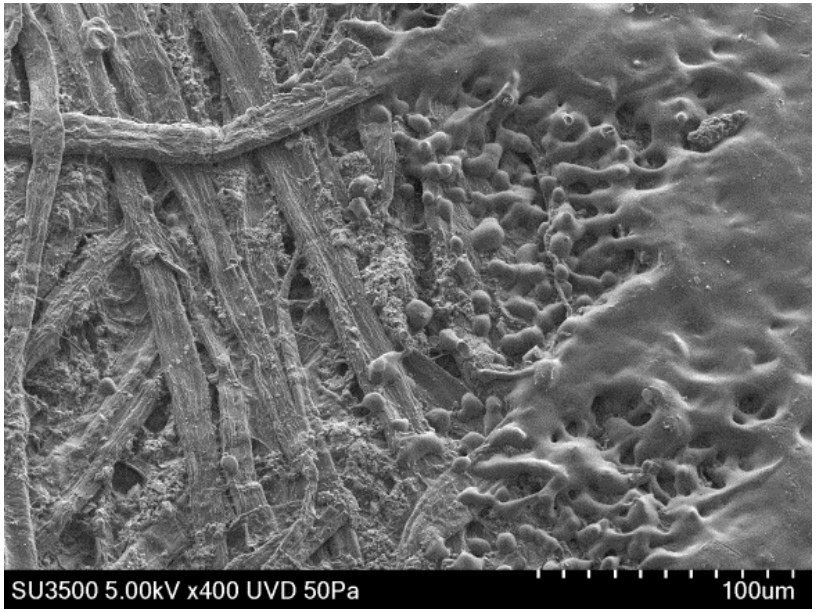
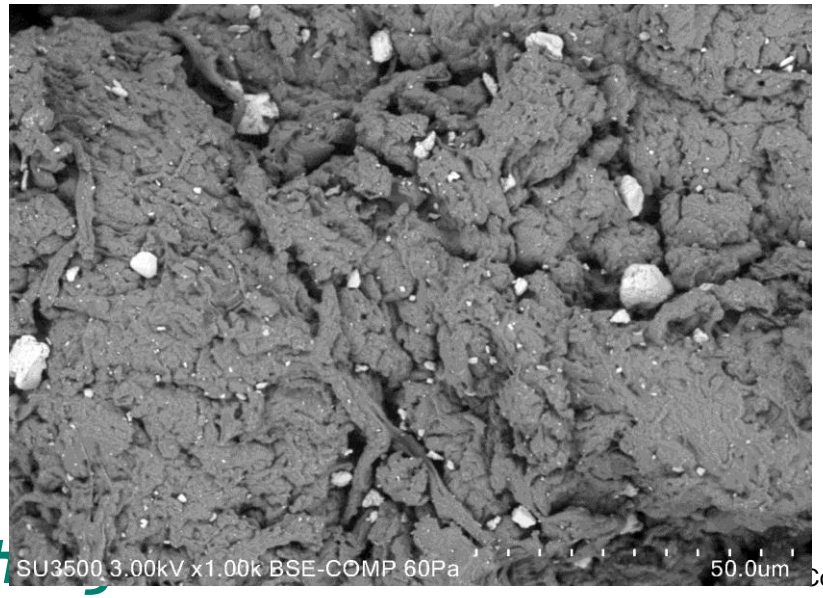
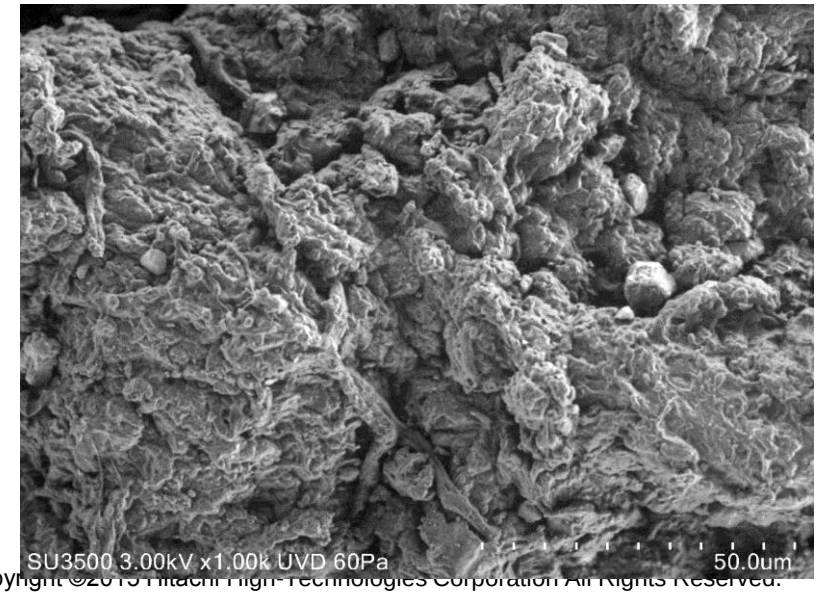
UVD Dedektörü









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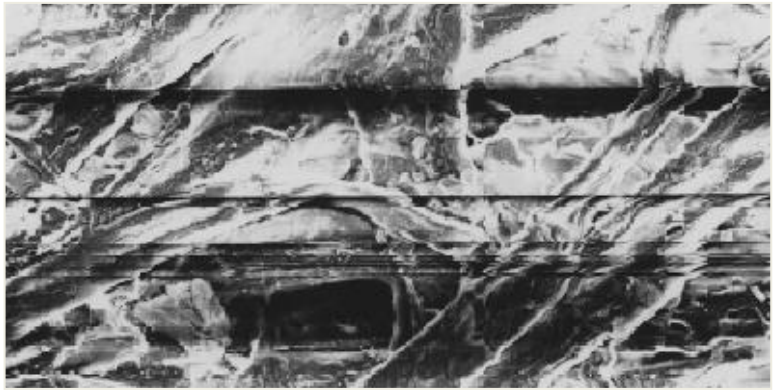
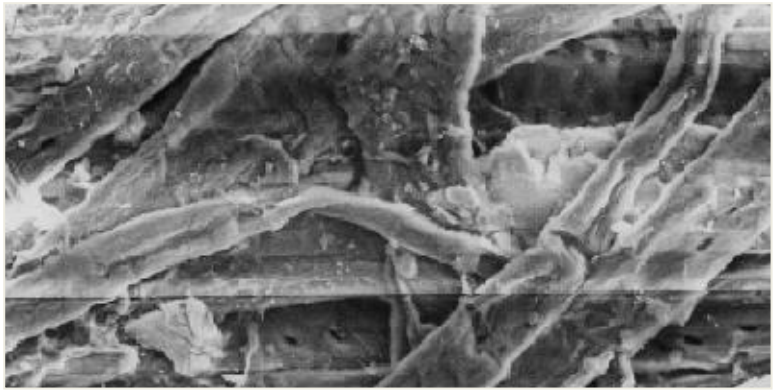
Charging

Pressure:
5 Pa

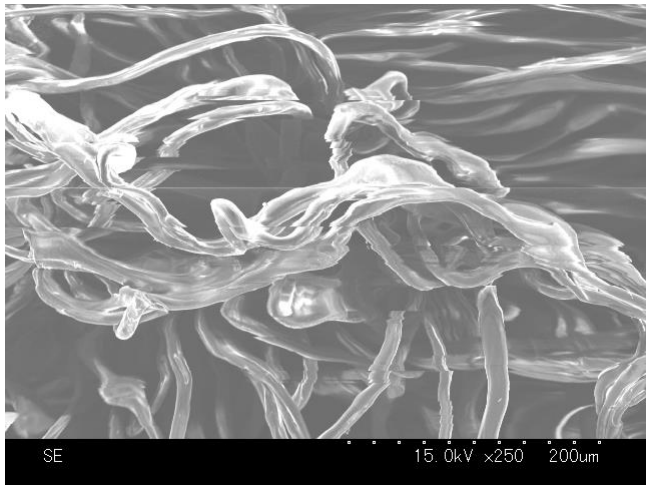


Pressure:
10 Pa

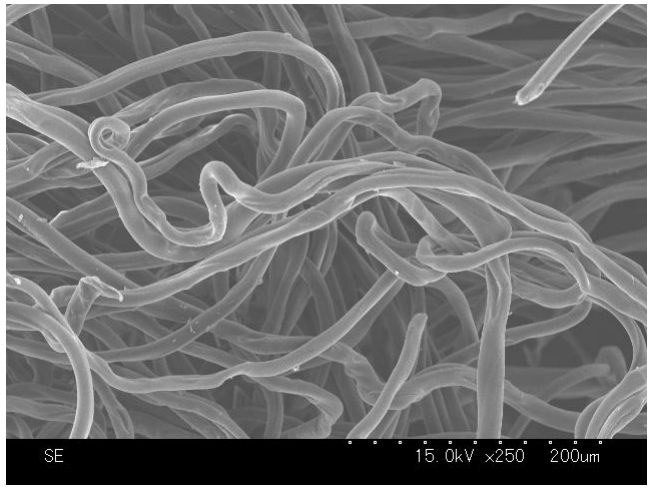


Pressure:
20 Pa

Kaplanmamış



Kaplanmış



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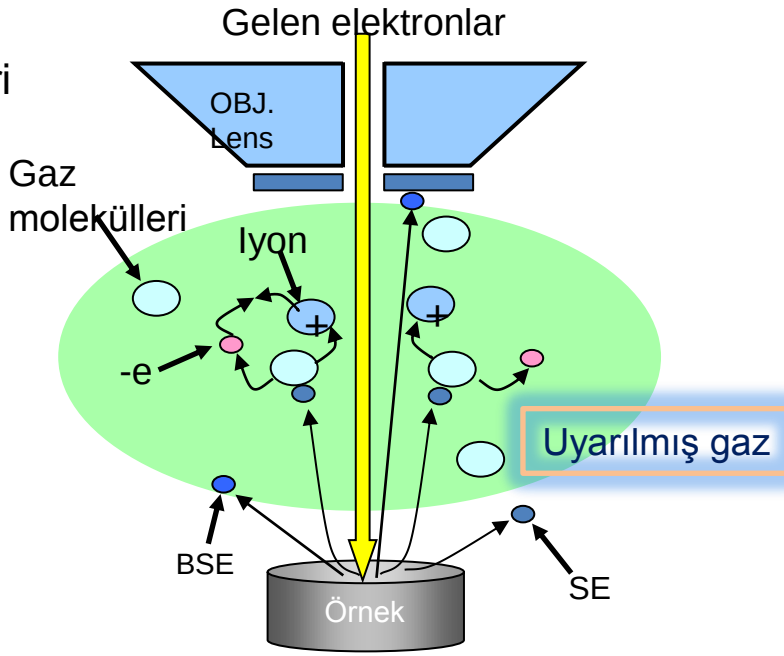
Vakum Modları(Değişken vakum)

- Yüksek Vakum Modu (İletken örnekler)
- Düşük Vakum Modu (Yalıtkan örnekler)

- Charging etkisini kaldırmak için iyonize gaz molekülleri



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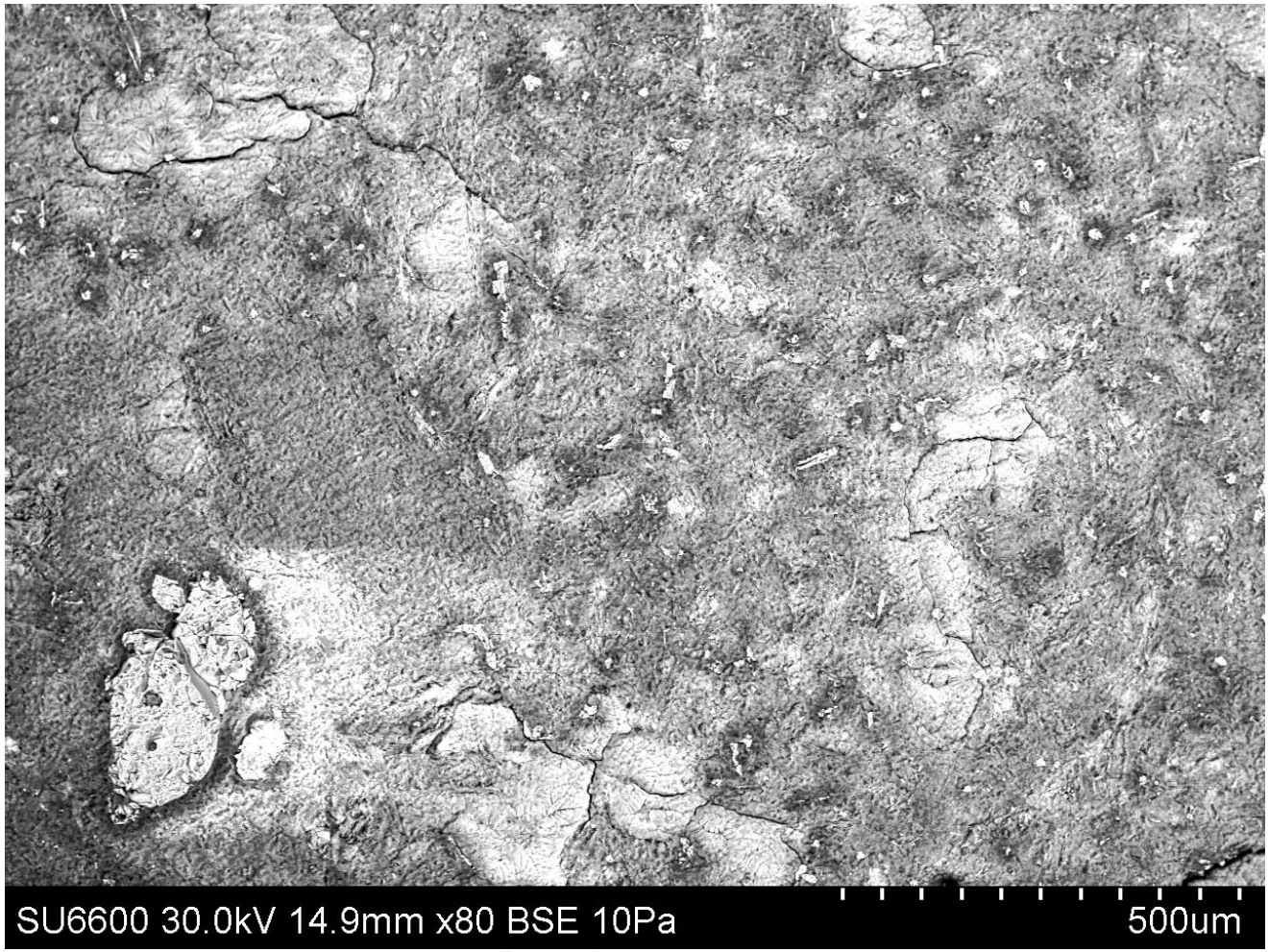
Değişken Vakum Modu Avantajı



Bazalt - kaplanmamış

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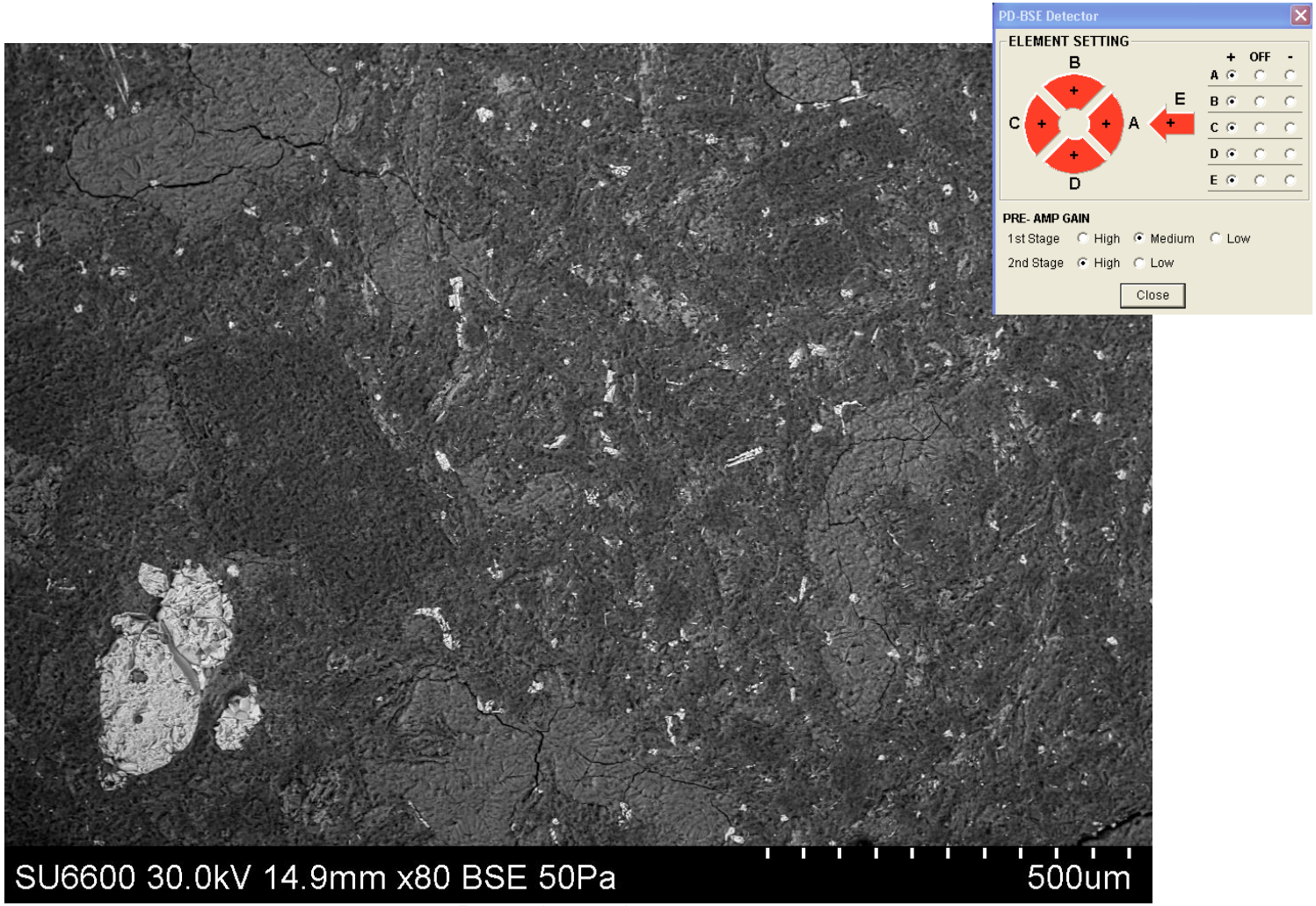
Değişken Vakum Modu Avantajı



Bazalt - kaplanmamış

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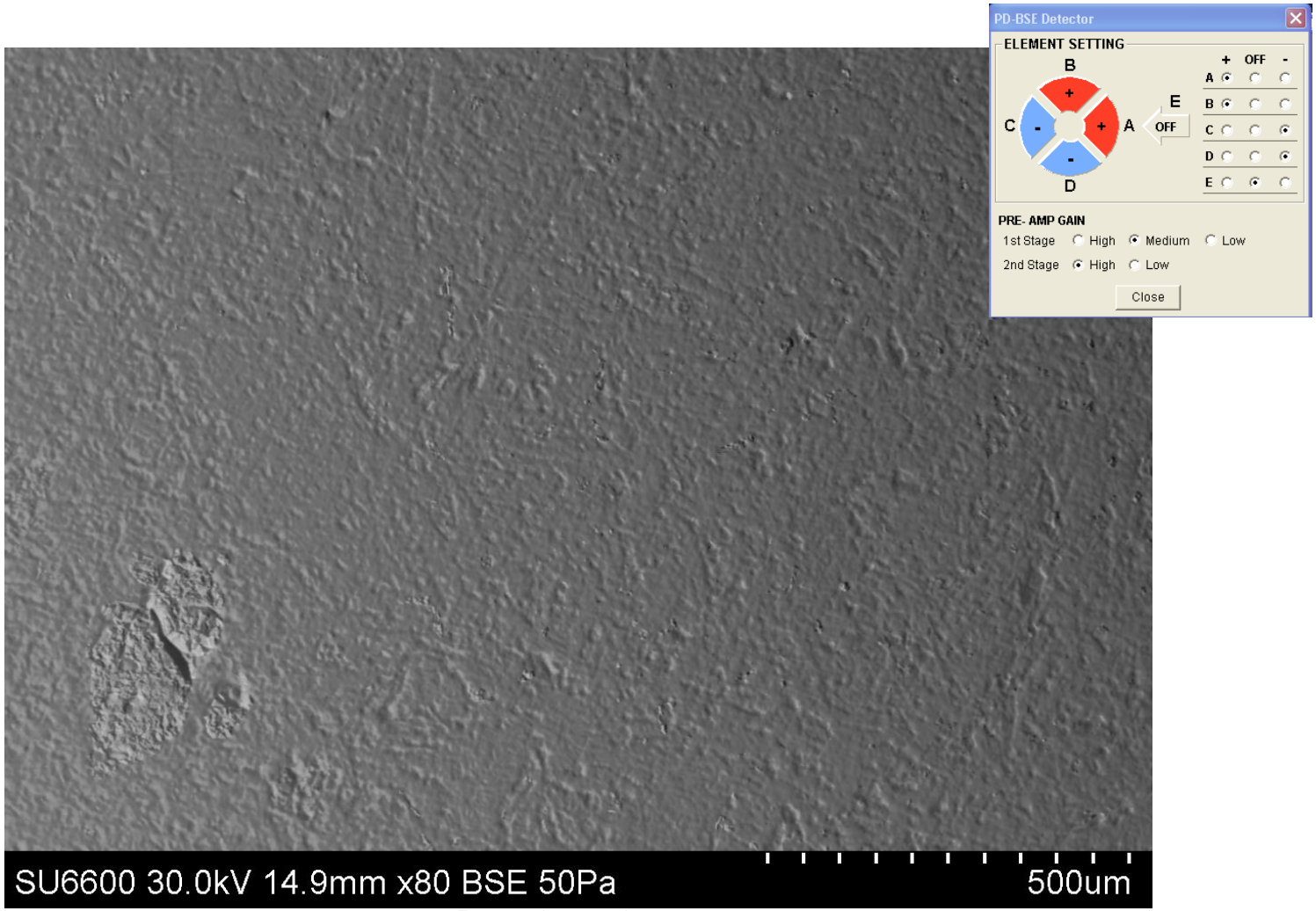
BSE Dedektör avantajı



Bazalt - kaplanmamış

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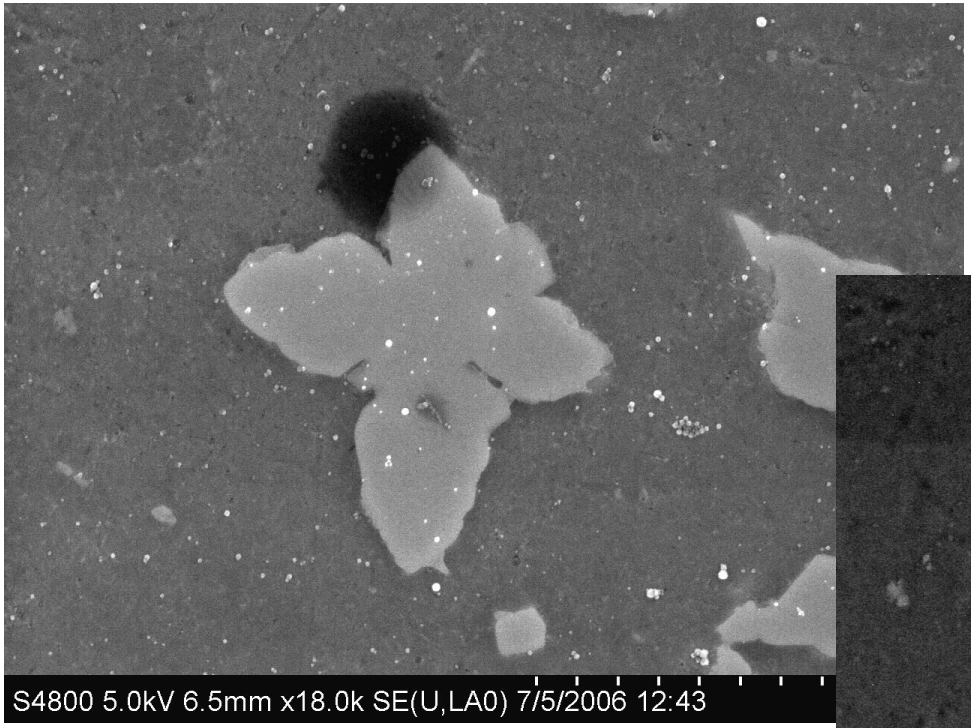
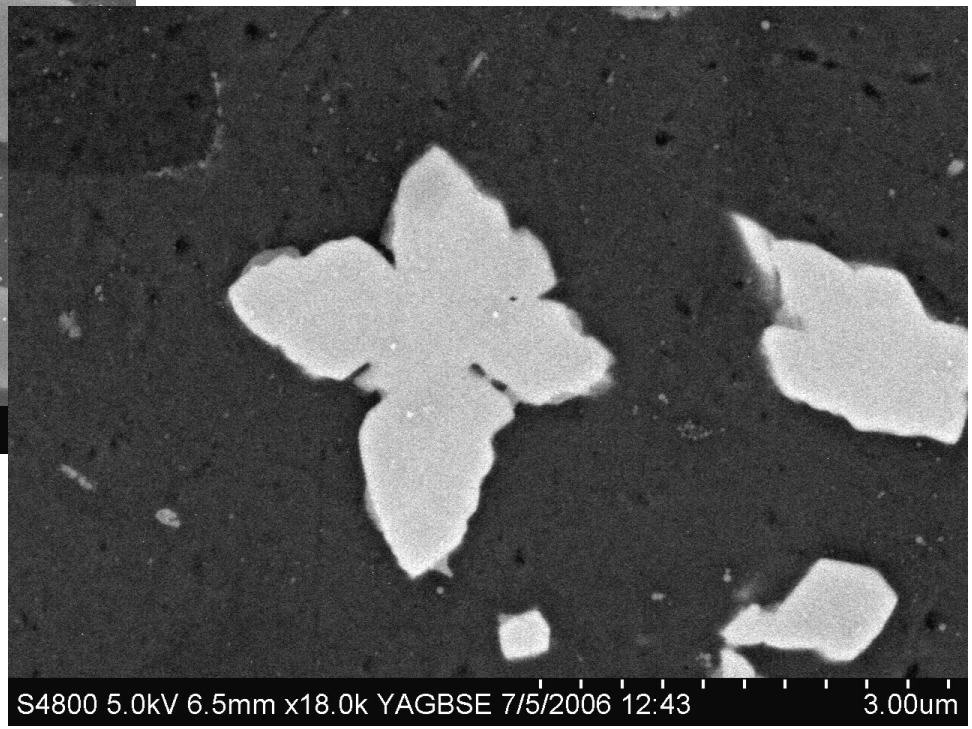
Al matrisdeki Al_5Mo dendiritik yapıları





Sample courtesy of Prof. Vilar, IST Lissabon

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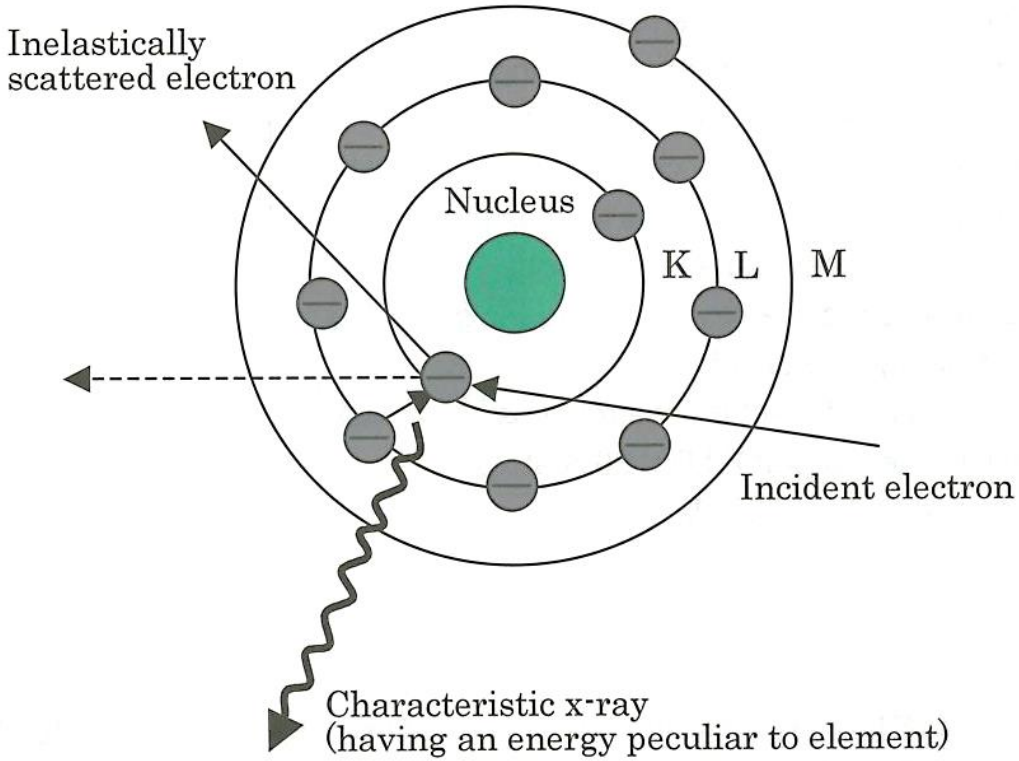
X-ışınları ve kimyasal analiz metodu



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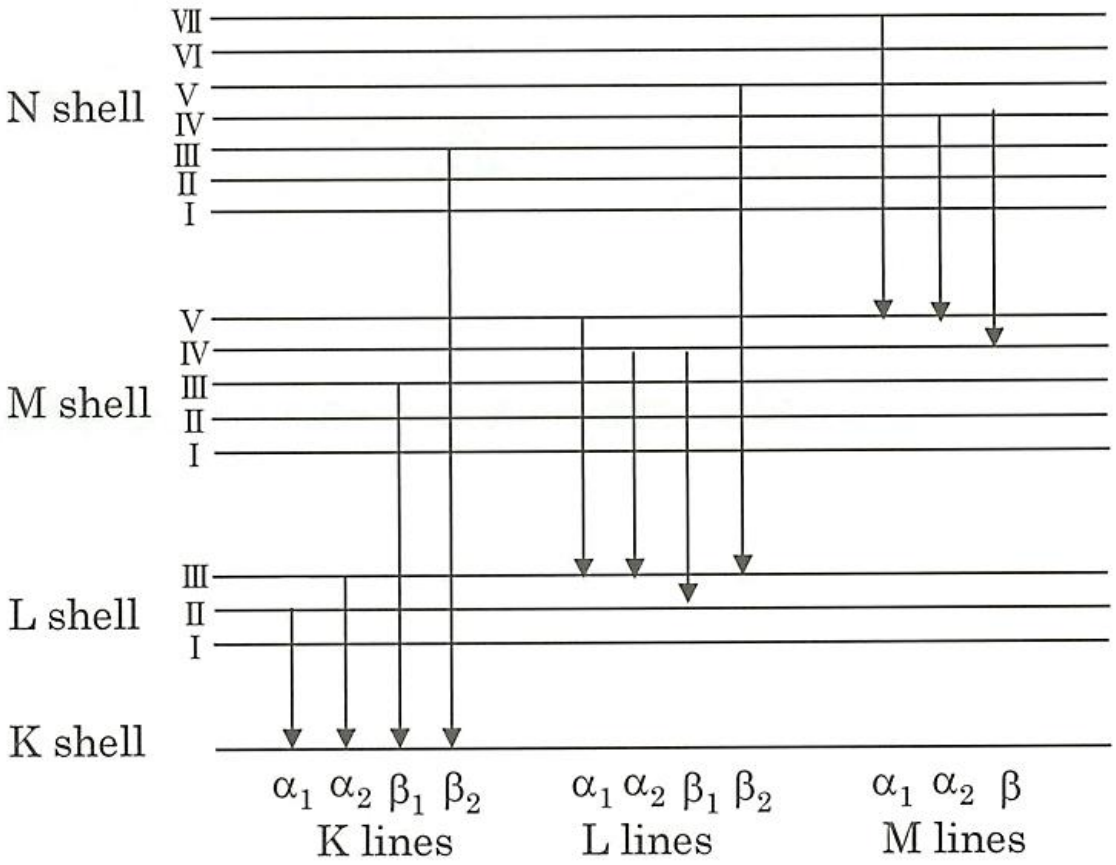
X-ışınları ve kimyasal analiz metodu



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X-ışınları ve kimyasal analiz metodu

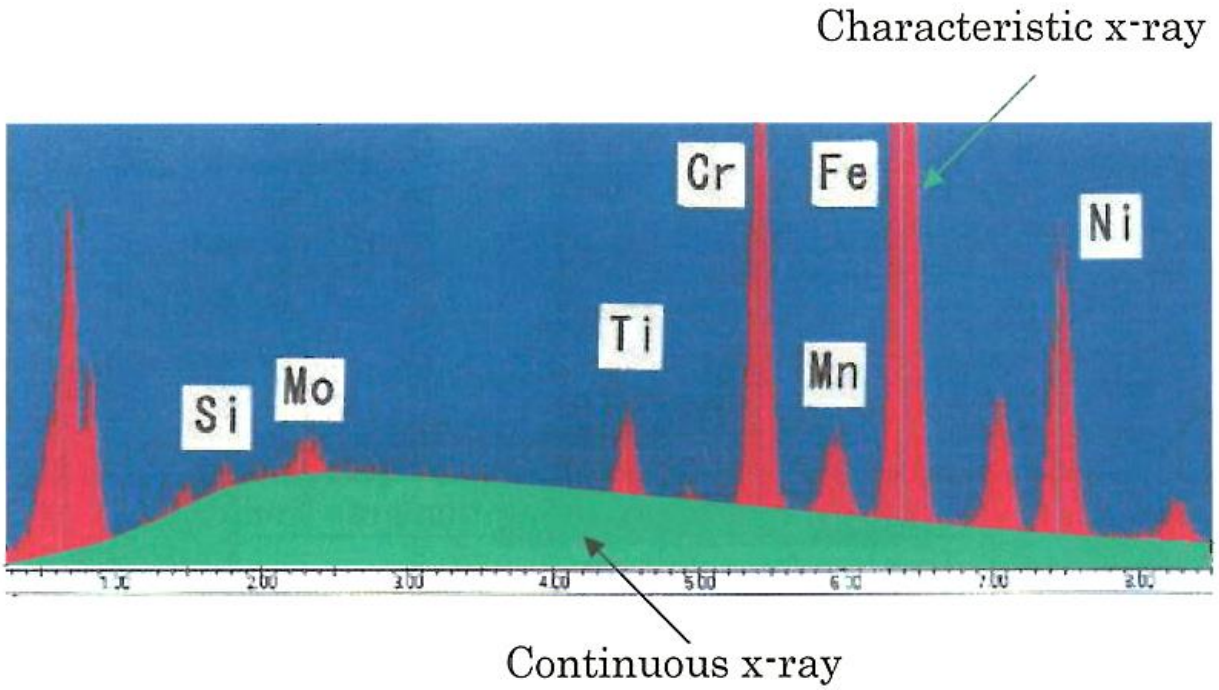

Fig. 3 X-ray Spectrum of Stainless Steel Specimen with Energy-dispersive X-ray Spectrometer

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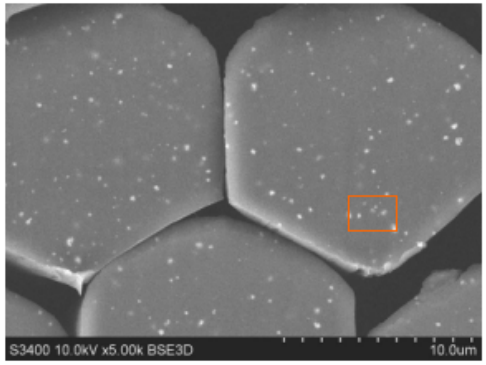
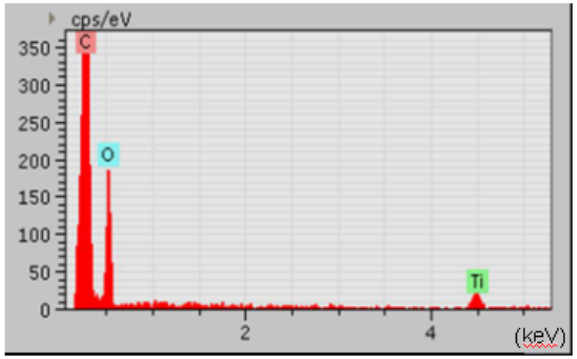
Kimyasal Analiz

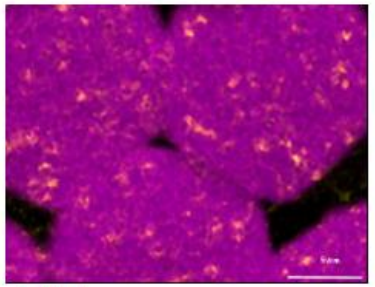


Backscattered electron image
(× 5,000 magnification)

The cross-sectional structure of the fiber was observed with a backscattered electron detector. This permits conformation of how the white particles are dispersed in the fiber.



X-ray spectrum of area enclosed in rectangle above



C Ti X-ray mapping image of C and Ti

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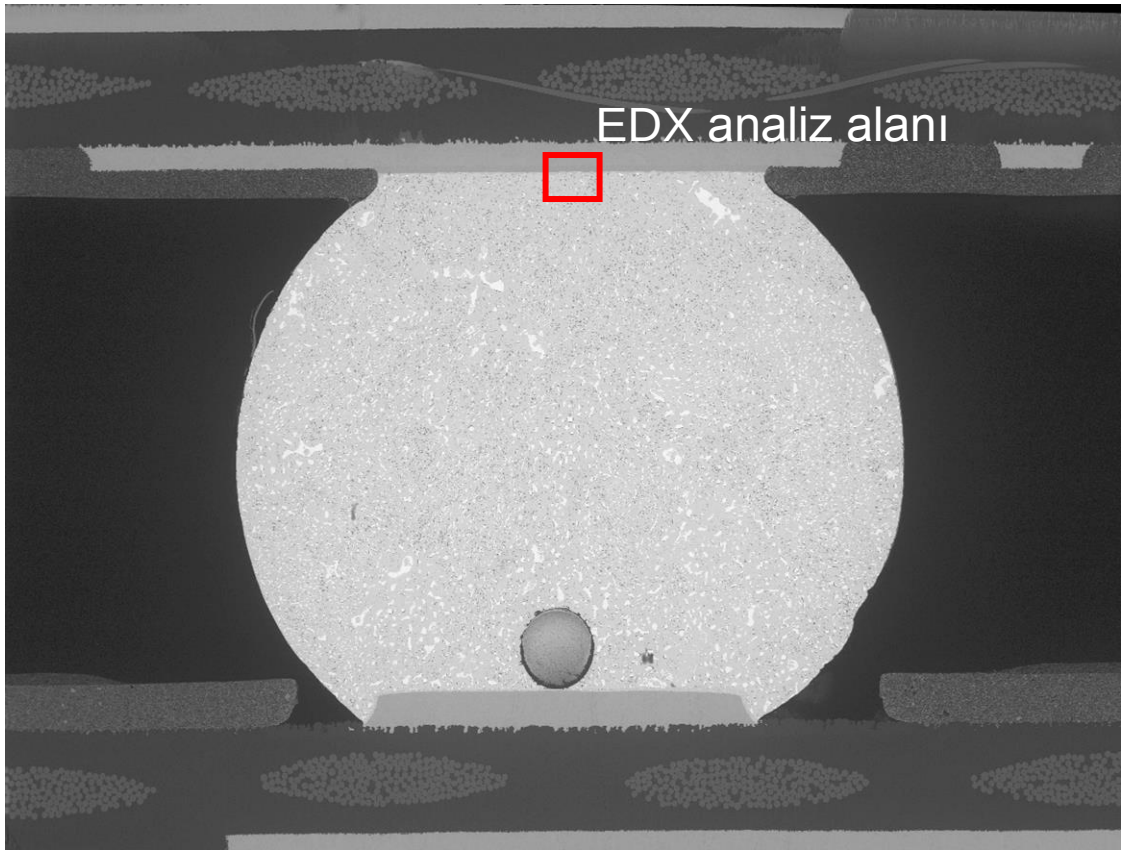
Kimyasal Analiz



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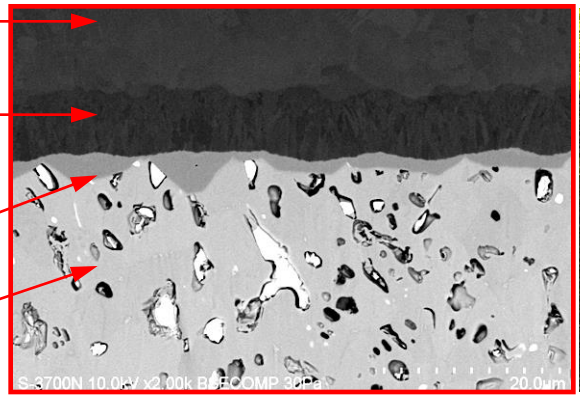
Kimyasal Analiz

Cu-tabakası

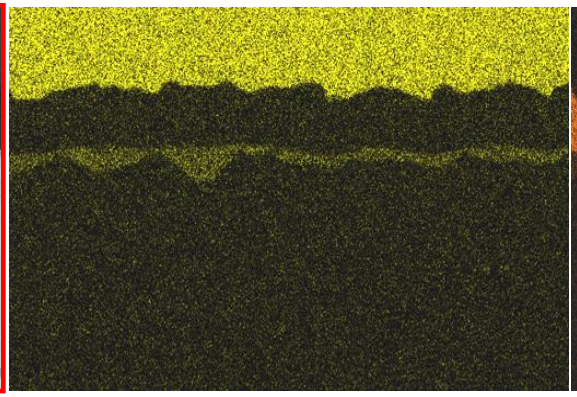
Kaplama tabakası

Alaşım Fazı

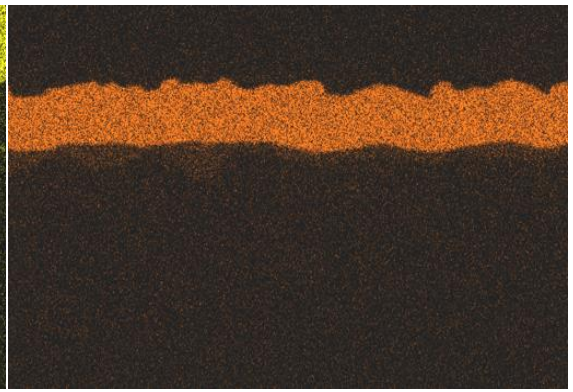
Lehim



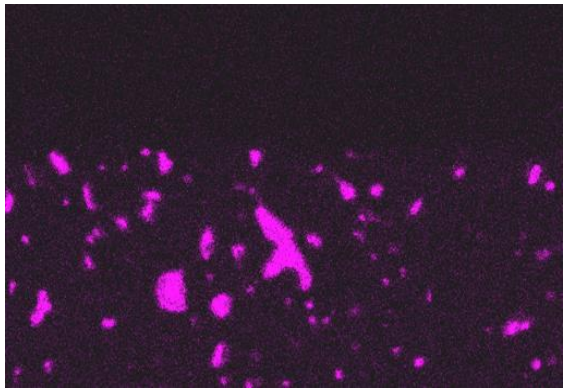
BSE görüntüsü (compo)



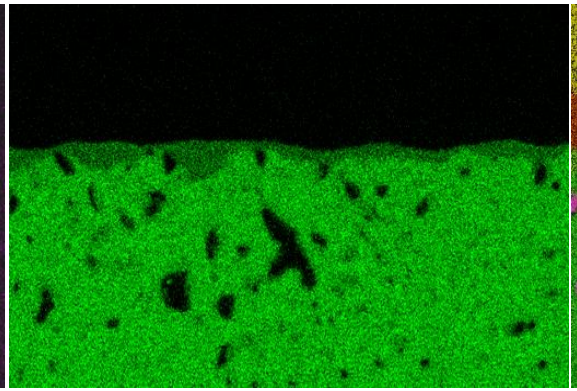
Cu-K



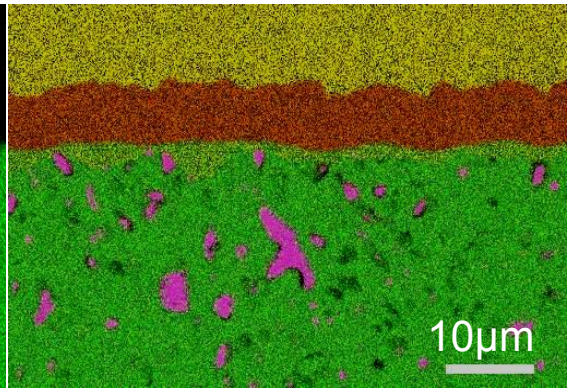
Ni-K



Pb-M



Sn-L



4 elementin üst üste gösterimi

Vacc. : 15kV Mag. : x2k Integration time : 3min

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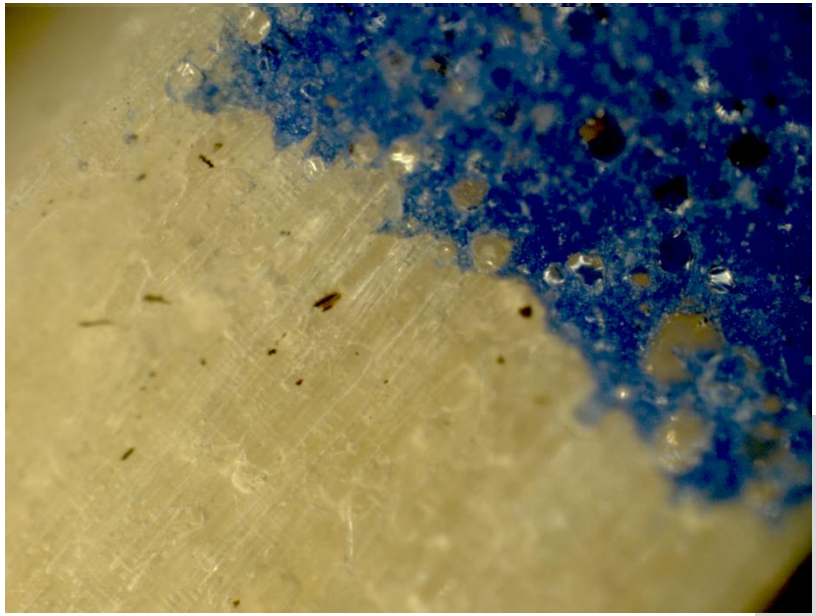
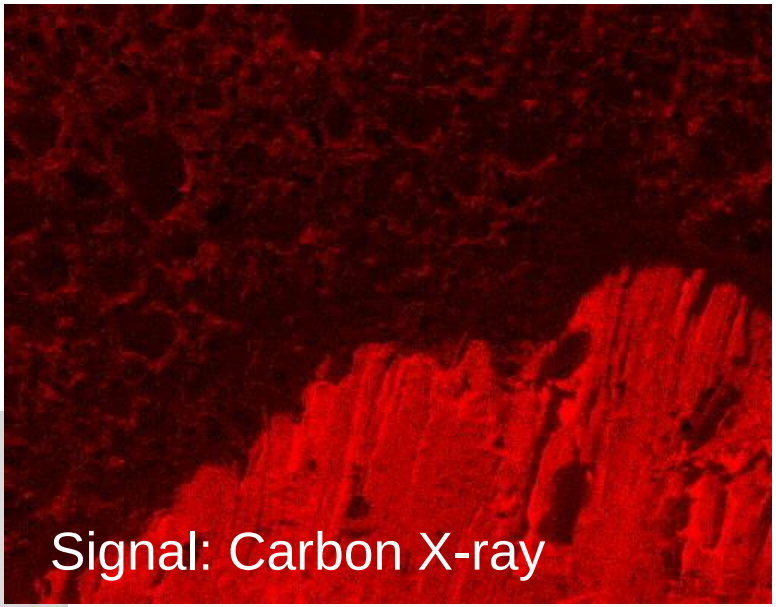
Kimyasal Analiz





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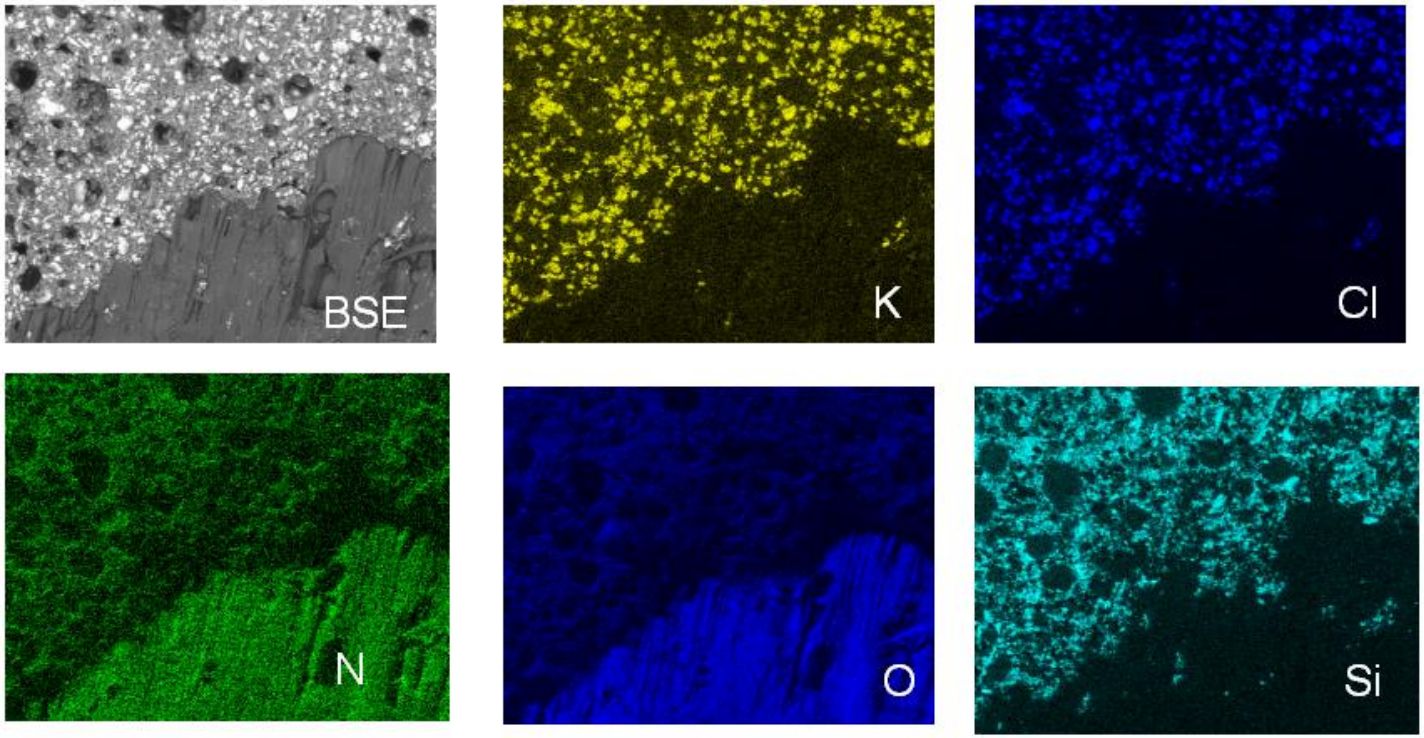

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