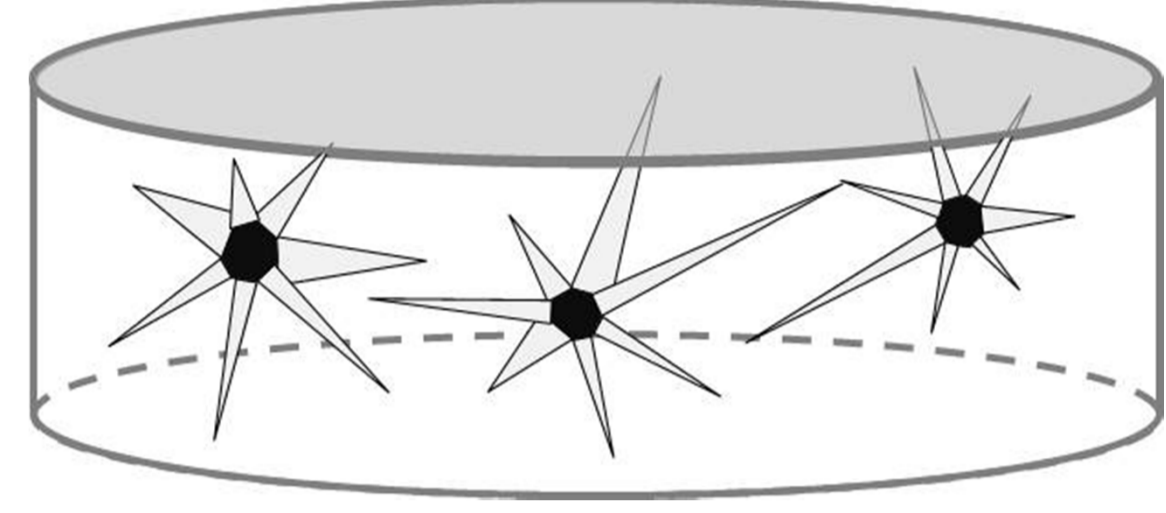




# Etching Methods for the Computerized Analysis of Acicular Ferrite in Steel Microstructures

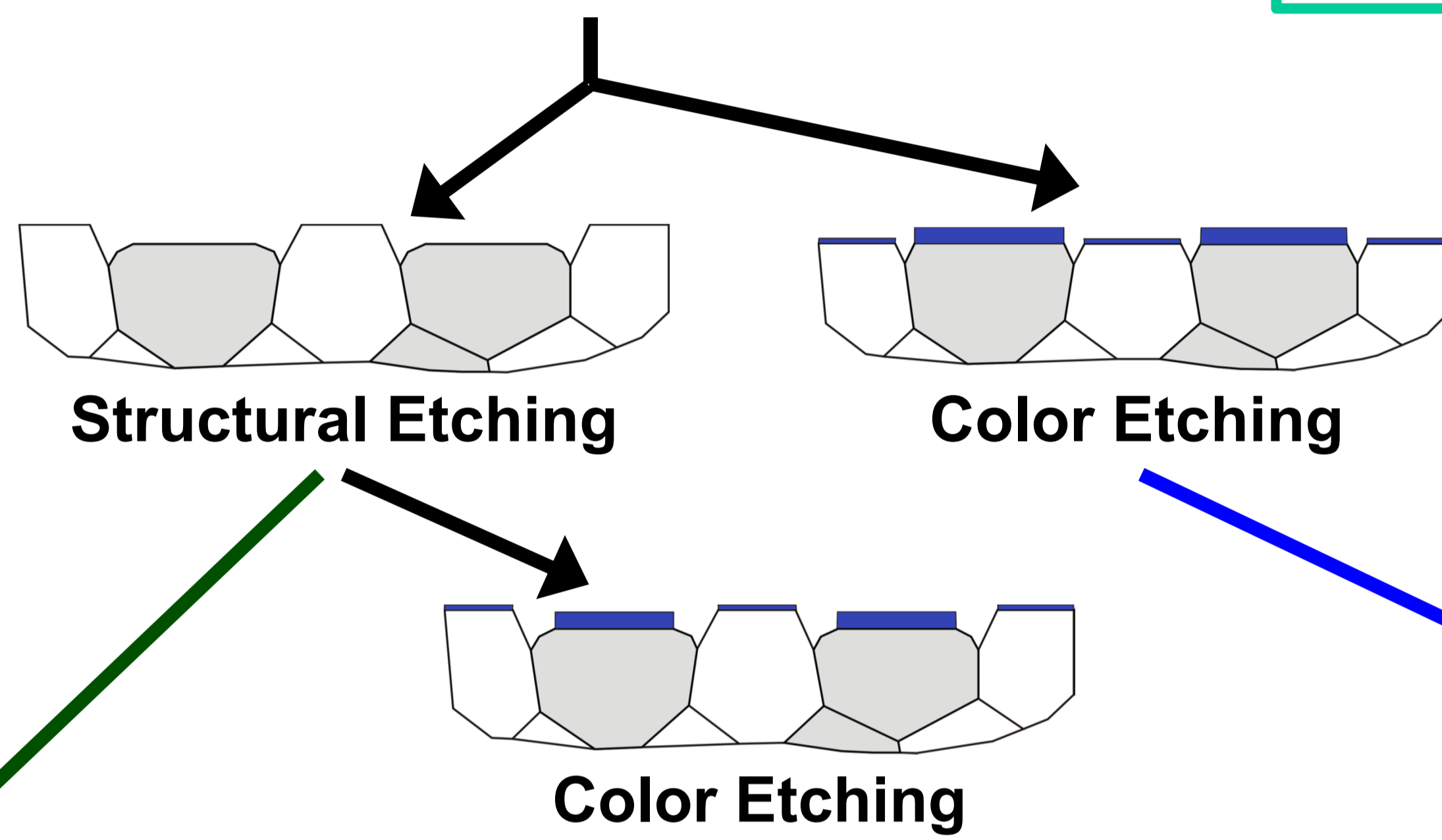
**Sample**  
with acicular ferrite  
microstructure



**Sample Preparation**  
cutting, grinding and  
microstructure optimized  
polishing



**Etching**  
single & two step etchings  
structural & color etchings

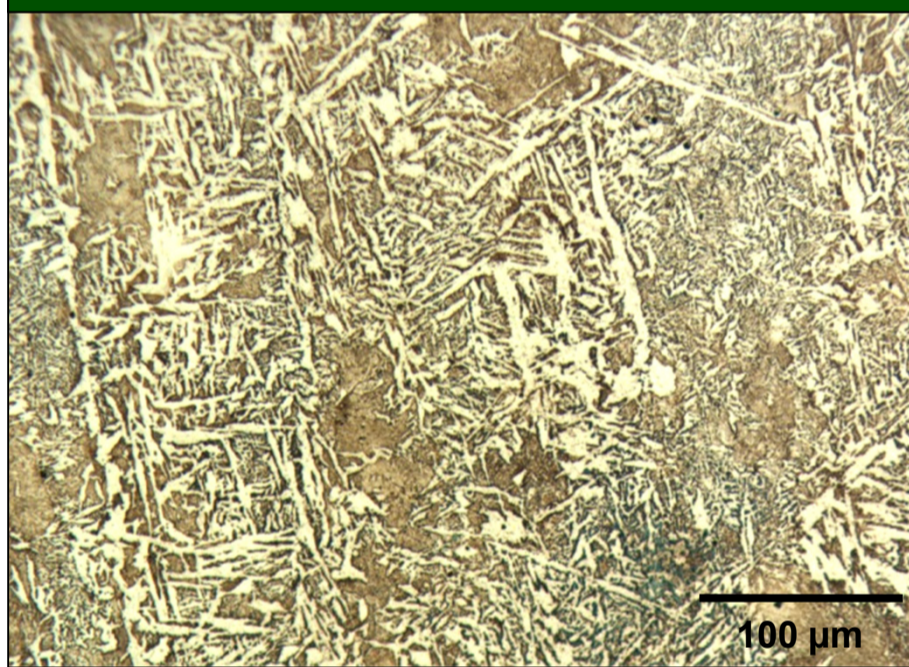


Since acicular ferrite provides excellent toughness, the properties of HSLA steels can be optimized significantly by increasing the amount of this component in the microstructure. Specific types of non-metallic inclusions are known to act as heterogeneous nuclei for the formation of acicular ferrite. In order to study the effect of different inclusion types and sizes on the acicular ferrite formation, a reliable and representative microstructure characterization is indispensable.

An accurate sample preparation is essential for the computerized analysis of acicular ferrite in microstructure. Scratches and stains caused by wrong polishing or cleaning can falsify the evaluation routine. Special attention has to be paid to a careful sample cleaning before etching, because residues on the sample surface can lead to an irregular etching.

For a computerized analysis a large contrast between the different microstructural phases is needed. Thus, five single step structural etching methods, 15 single step color etching methods and 19 two step etching methods (combined structural and color etching) were tested on a low alloyed steel with 0.23 % C, 1.50 % Mn and 0.05 % Ti. Ten etching methods offered an adequate contrast for an automated determination of acicular ferrite by an image processing program.

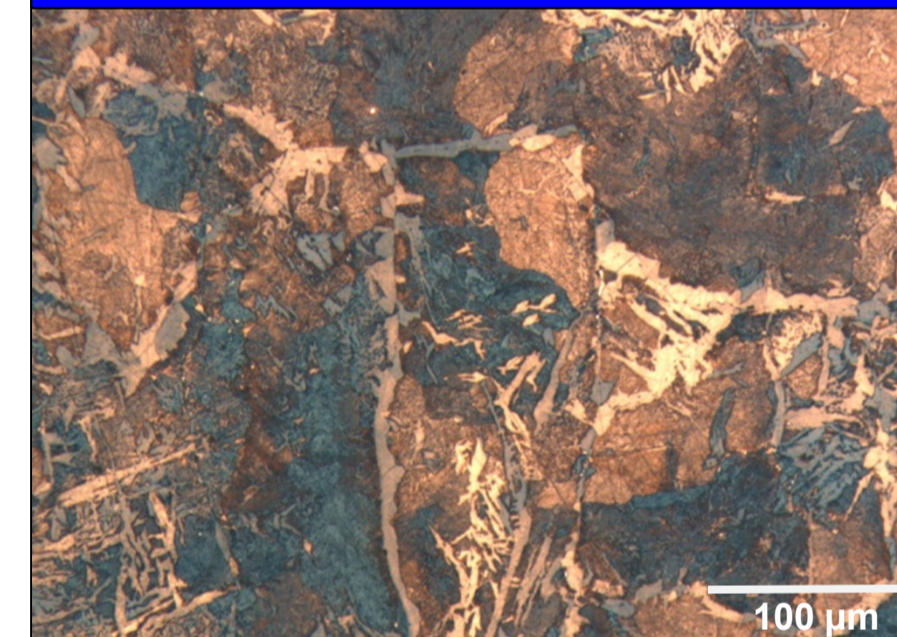
V2A-Pickle



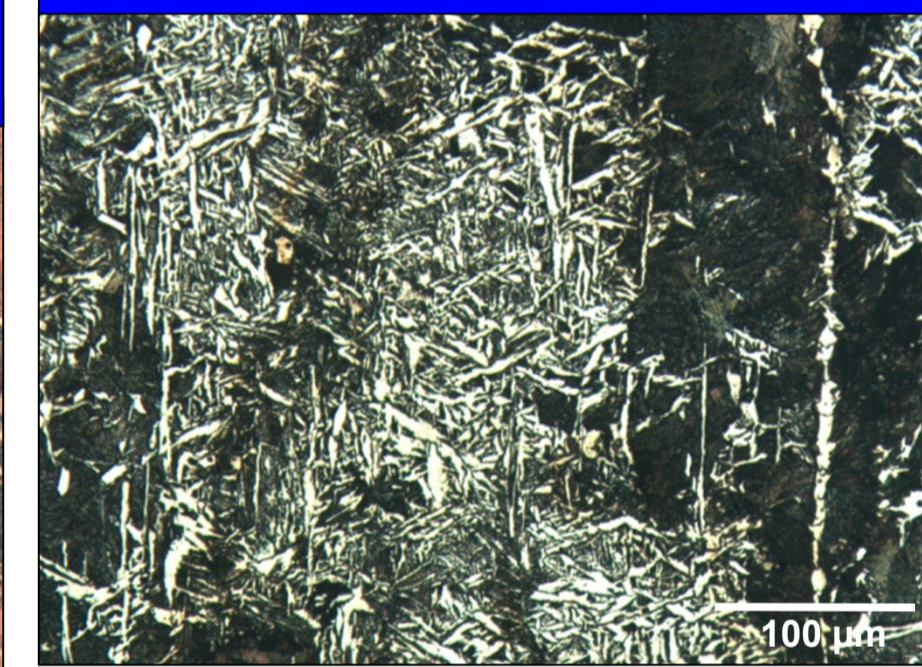
Vilella



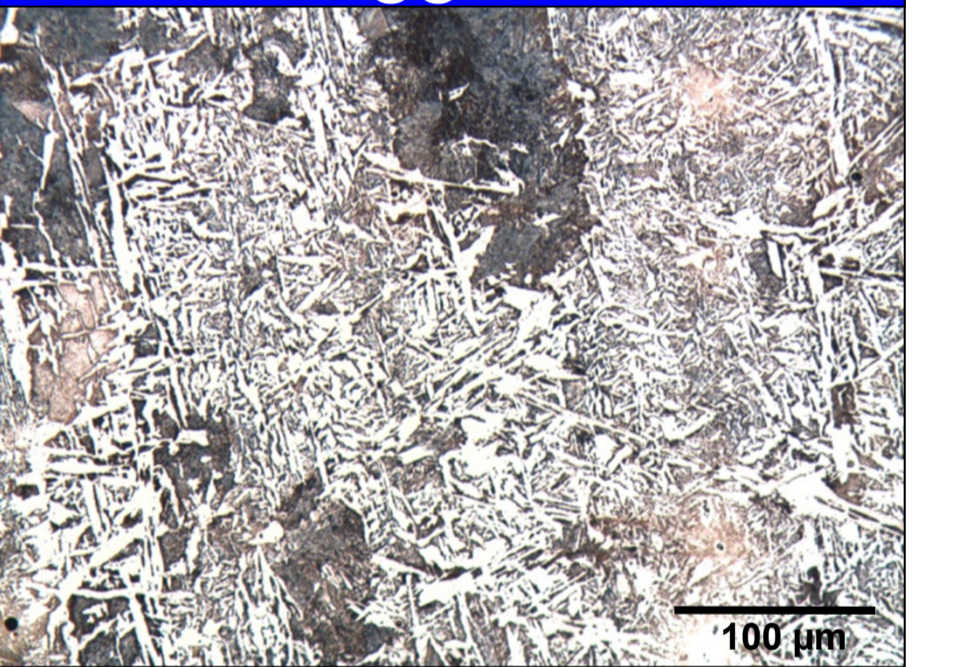
Modified  
Lichtenegger&Bloech



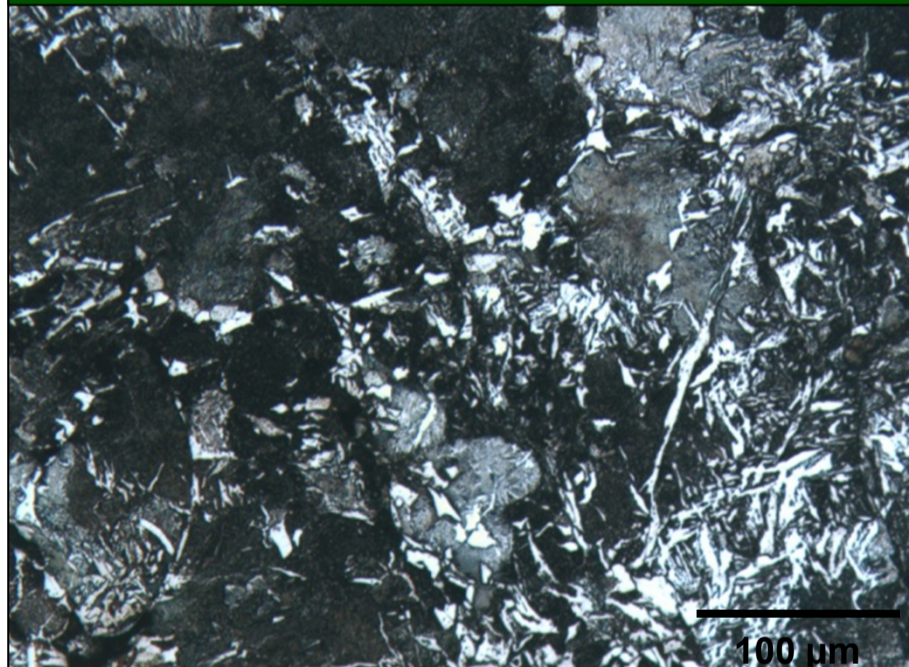
Beraha II



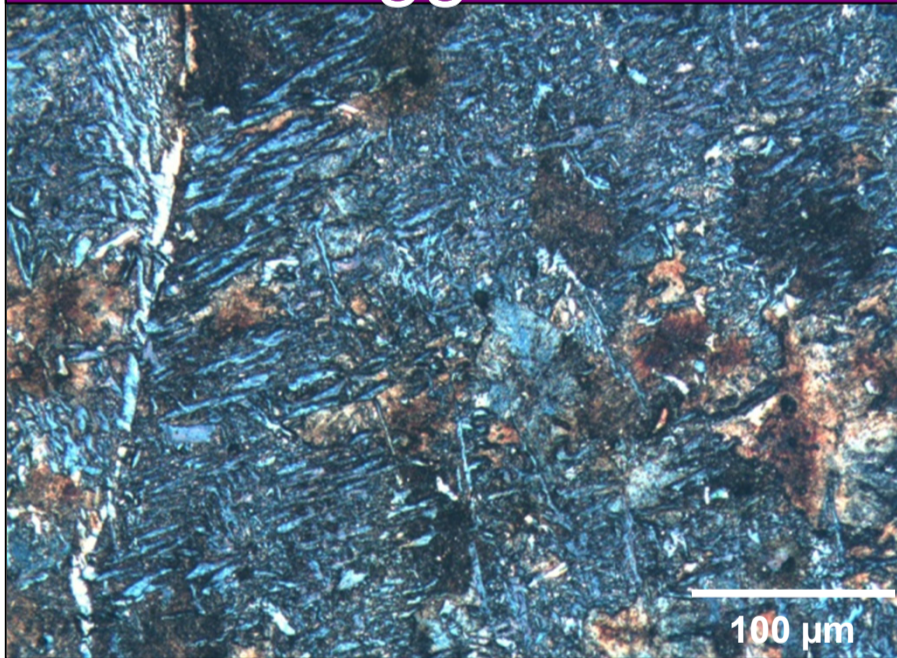
Lichtenegger&Bloech



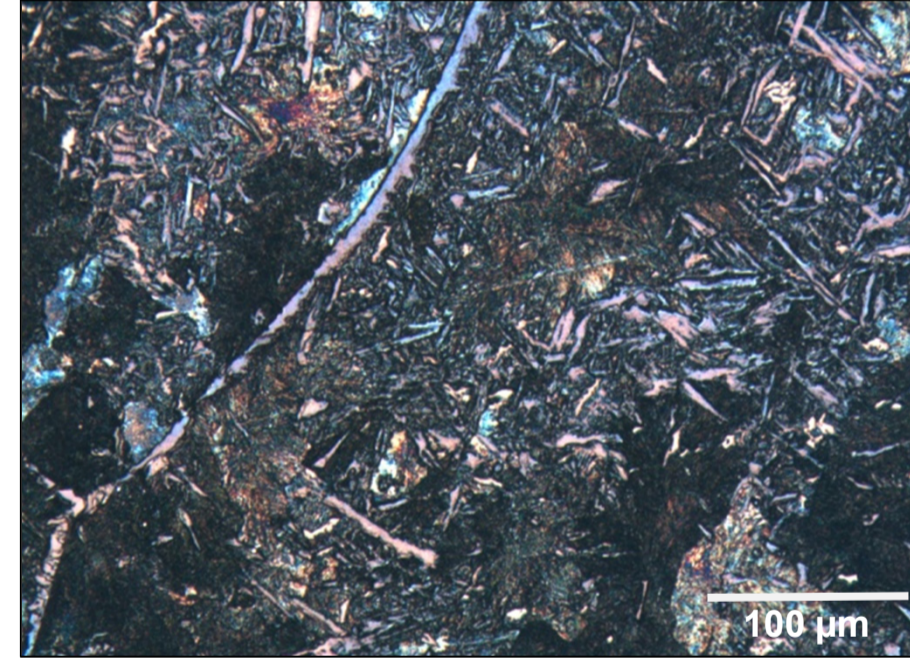
Nital



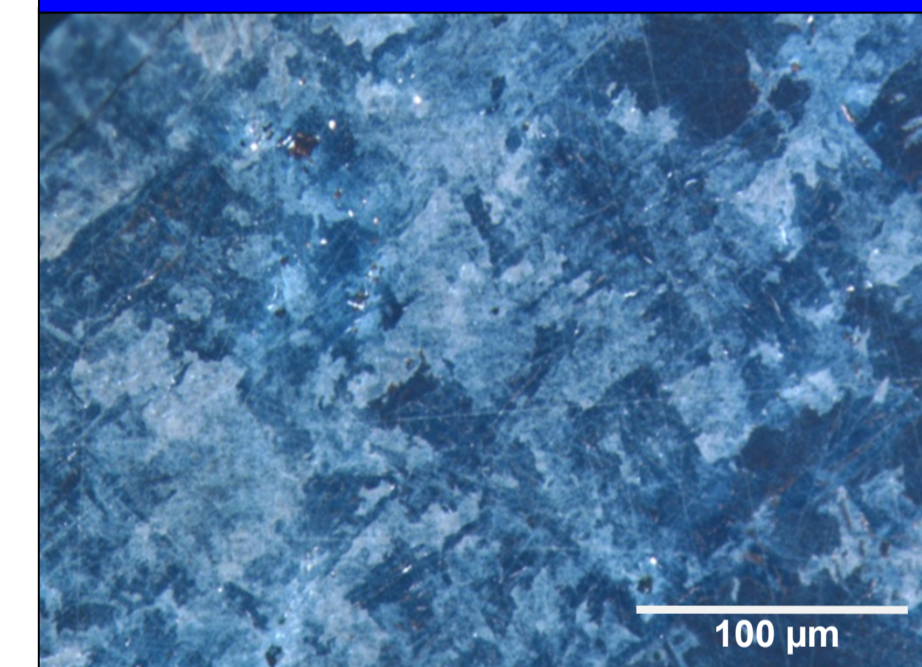
V2A-Pickle + Modified  
Lichtenegger&Bloech



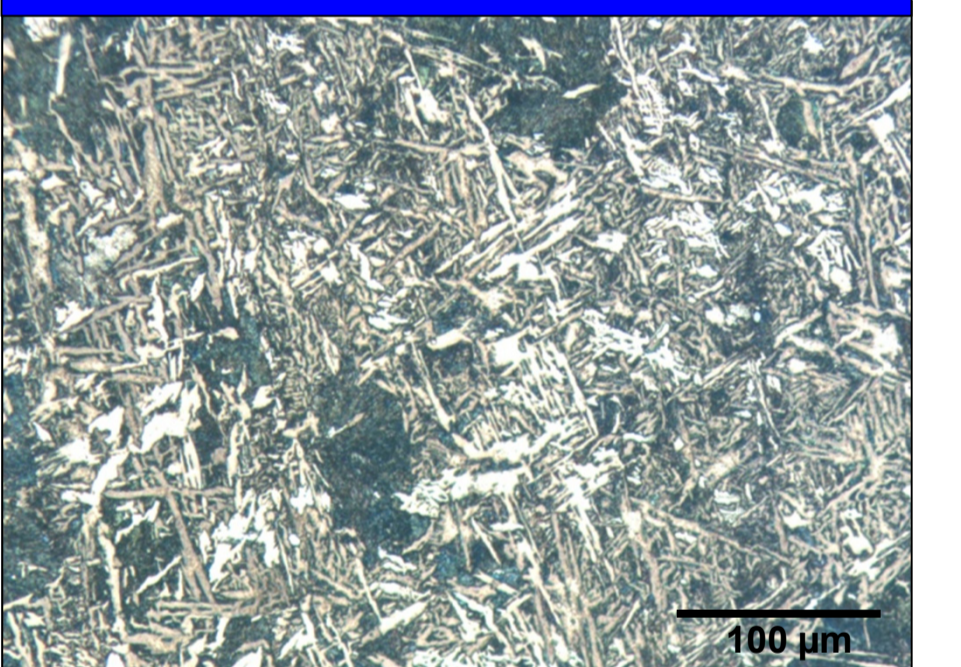
Nital + Malette II



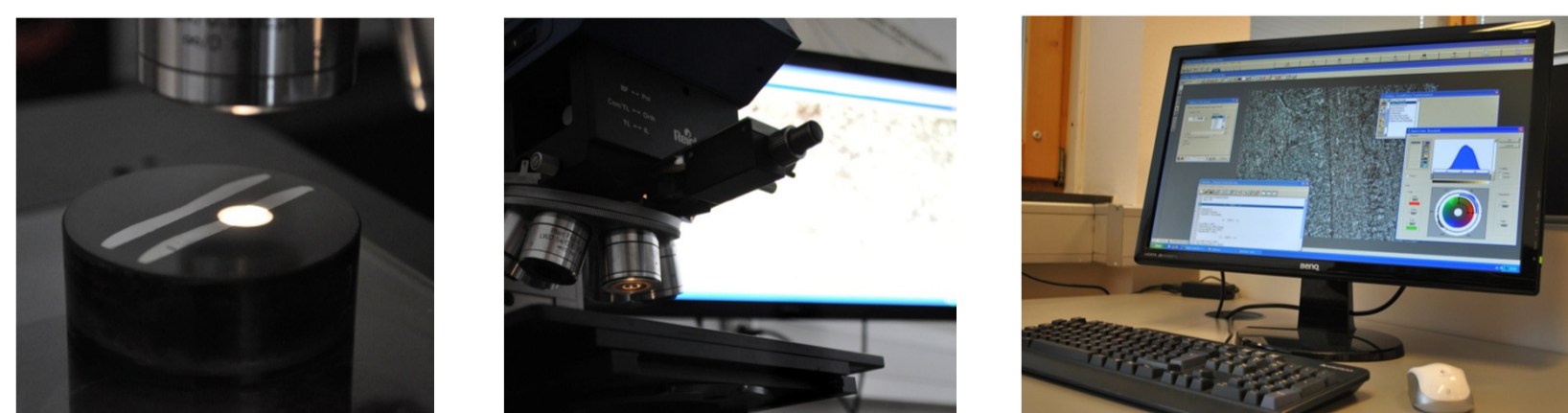
Klemm I



Malette II



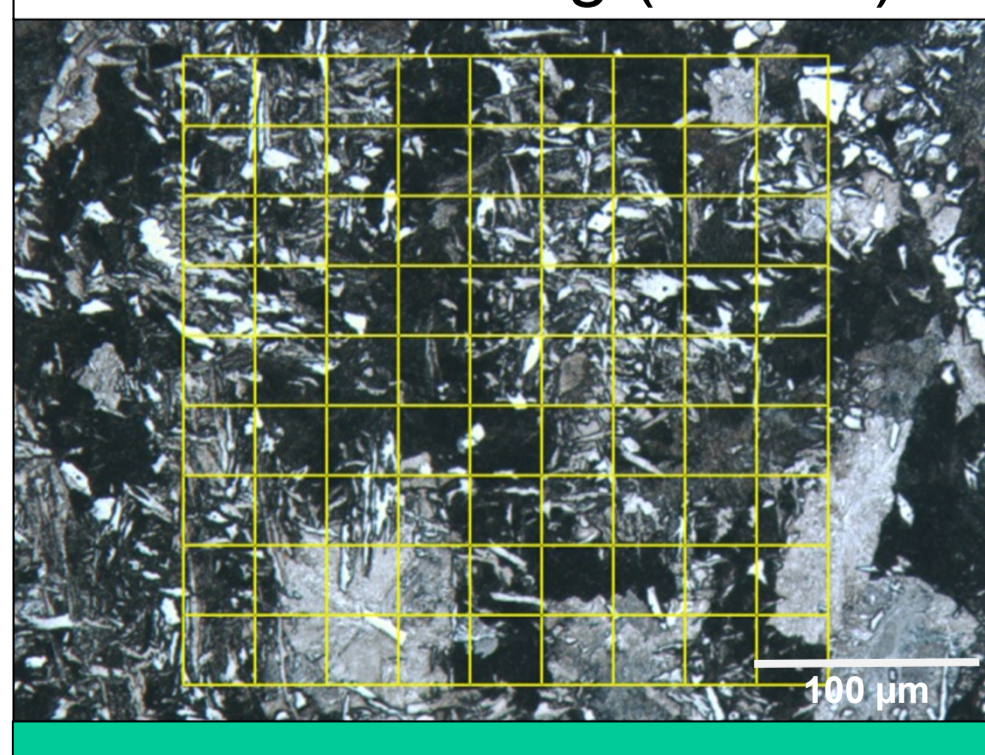
**Computerized Analysis**  
using an image processing  
program



The amount of acicular ferrite in microstructure was determined automatically using an evaluation routine: Selection of ferrite by color thresholds – Sorting out polygonal ferrite and Widmannstätten ferrite by grain size (yellow marked) – Mending grain boundary etching by grain expansion – Calculation of selected acicular ferrite area (red marked).

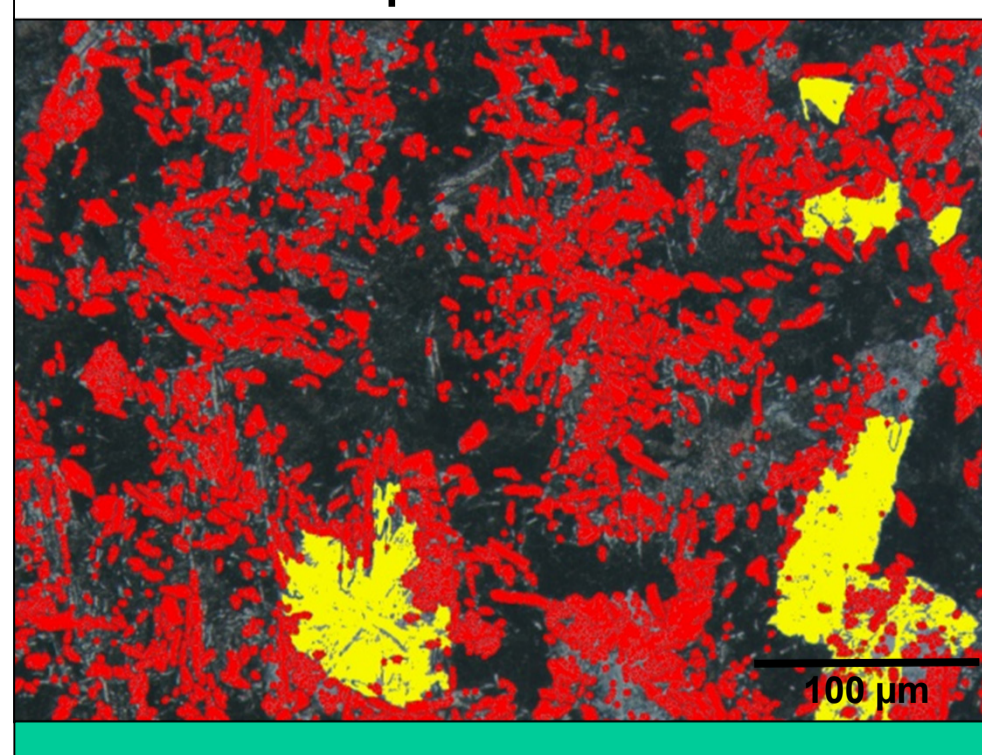
**Comparison**  
with standardized  
point-counting method  
(Nital etchings)

Point-Counting (Stand.)



43.5 % AF

Computer Based



44.3 % AF

For the evaluation of the tested etching methods concerning their practicability for a computer based acicular ferrite investigation the etched microstructures are analysed by the developed routine (right picture) as well as by the manual standardized method according to ASTM 562-11 (left picture). The results of these two analysing methods are in very good agreement, both methods show an acicular ferrite amount of about 44 % in the tested sample.

