In conventional AISI M42 tool steel production route the steel is cast and then forged in a temperature window between 1100 °C to 1150 °C. At those temperatures metastable M2C carbide phase transforms into stable carbides as M6C and MC following the phase transformation M2C + matrix → M6C + MC. This is well known and accepted equation. In the present study SEM based EBSD and EDS analysis was applied to characterize the transformation of eutectic carbides during annealing of AISI M42 steel at the typical forging temperature of 1100 °C. Specific large eutectic carbide grains were characterized before and after annealing for different times. It was found that MC carbides appeared to form independently from the transformation of M2C to M6C. During M2C transformation some vanadium diffuses out of the newly formed M6C and enriches the surrounding matrix. Due to a higher concentration of vanadium in matrix, formation of vanadium rich MC carbides is favourable (Fig. 1). Results have also shown an interesting difference in carbide transformation reactions on the surface versus the bulk of the alloy, presumably due to the operation of different diffusion processes. Observing the transformation in the bulk shows that the transformation of M2C to M6C started on the M2C/matrix boundary and grew into inner region, while observing the carbide transformation phenomena on surface shows that the metastable carbides as well as the matrix is covered by a thin layer of M6C. It has been proven that in-situ analysis might not give the same results as you get it when the sample is annealed and cut in order to observe inner region.
Fig. 1: Transformation of carbides during annealing at 1100 °C for 30 minutes. The arrows show the EBSD spot analysis performed at certain carbides.