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3D-characterization of growth defects in sputter deposited TiAlN hard coating using SEM/FIB

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In PVD hard coatings, micro and macro-defects typically appear during the deposition. The main representatives are: (a) large and shallow craters with diameters greater than 5 µm, (b) nodular defects with diameters in range 1-5 µm and (c) small micro-size holes (so called pin-holes). These surface imperfections in the coatings can cause local stresses, higher friction, sticking of work piece, local loss of adhesion and pitting corrosion. All the above mentioned facts are drawbacks in the application of hard coatings. Therefore, it is very important to reduce their concentration.
In this paper we tried to solve the question regarding the formation of a defect at a specific location, and whether such a defect can cause pitting corrosion. It was found by examining several defects that 3D imaging and analyzing provide new insights in understanding growth defect formation as well as its influence on corrosion processes, which might help to solve challenging problems regarding extension of the coating/substrate system lifetime.
Magnetron sputtering system CC800/7 was used for the deposition of TiAlN hard coating. D2 cold work tool steel was used as substrate material. The growth defects embedded into the coating were studied before and after a corrosion test. The defect morphology and distribution of defects were studied with field emission scanning electron microscopy (SIRION NC400, FEI).Focused ion beam (SEM-FIB) installed in a conventional SEM (QUANTA 200 3D, FEI) was used to prepare different cross-sections through the defect. SEM-FIB cross-section images were then put together into a 3D-image of the defect with graphical program.

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