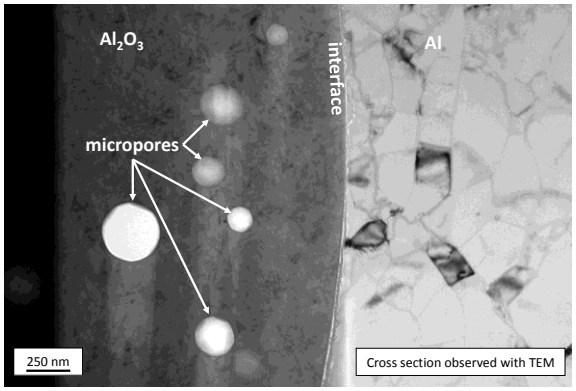
Role of the microstructure on the marine corrosion mechanisms of cold spray Al-based coatings

Pierre-Emmanuel LEGER
(2014 – 2018)

Industrial Partner: -
Supervisor: Michel Jeandin
Thèse soutenue le 17 janvier 2018



- Al-based coating production with a wide range of powders on a steel substrate
- Multiscale porosity study
- Determination of corrosion mechanisms

Abstract:
Cold spray process is based on spraying particles carried by a gas at a supersonic speed onto a substrate. Particle deformation during impact with the substrate creates a coating. This spraying process can retain particle microstructure and produce very dense coating. This property is crucial for anticorrosion applications. The aim of this work is to understand the effect of cold spray aluminum coating microstructure on marine corrosion mechanisms. To achieve this goal, several aluminum powders (including pure aluminum, aluminum alloys and mixtures with alumina) are sprayed onto a steel substrate. Coating microstructure is studied down to a nanoscale (TEM). The coating-substrate bond strength is determined using pull-off testing. From a thorough microstructure study, various mechanisms are proposed to explain multiscale porosity formation in coatings. A numerical study using finite elements modeling complements this microstructure analysis. From particle speed (DPV-2000) and temperature (thermal camera) measurements during impact, new material models are optimized to model aluminum and alumina behavior at particle impact. Moreover, corrosion tests are conducted (including immersion and salt spray tests). The study of corroded coating microstructures is used to identify corrosion mechanisms which occur in the coating. A relationship between coating porosity and its corrosion behavior is particularly brought into light. Finally, a first approach to a technological transfer of this process to an industrial application is proposed.