

How to adapt Micro-Speckle Patterning to achieve High Resolution Strain Imaging during In-situ Scanning Electron Microscope (SEM) tensile testing

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Keywords: speckle patterning, Digital Image Correlation, microstrain partitioning, in-situ testing

Two-dimensional Digital Image Correlation at the microscopic level (μ -DIC) is a non-contact method of tracking local in-plane deformation that has been widely applied since the 2000's to a diverse range of materials - from hard metals to soft biological materials [1]. A set of microscopic images are taken during in-situ testing from the undeformed state until fracture. The spatial resolution and the range of local strain that can be measured is dictated by the speckle pattern preparation – both the nature of the patterning used and its quality. A great deal of research has been done to develop micro-speckle patterning techniques [2], such as: chemical etching, deposition of disperse colloidal particles (e.g. silica, silver or gold), mask-less lithography, etc. However, very little research has focused on correlating patterning quality to that of DIC local strain measurements using multiple techniques on a single material. In addition, for some materials such as those exhibiting transformation-induced plasticity (TRIP), the coupling of EBSD mapping with in-situ deformation and μ -DIC on the same local region is a powerful method for correlating local strain to microstructural evolution. This combined technique has gained ample popularity in recent years, especially in characterizing the local deformation and damage of 3rd Generation Advanced High Strength steels with multiple indistinguishable phases and ultra-fine grain sizes. In this talk we will compare the μ -DIC mapping quality for a series of micro-speckle patterning methods, including randomized FIB hole milling and platinum speckle deposition, on a post-EBSD scanned region of an experimental 3G Medium Manganese steel with ultra-high (1000-1300MPa) strength and significant (16 – 27%) ductility.

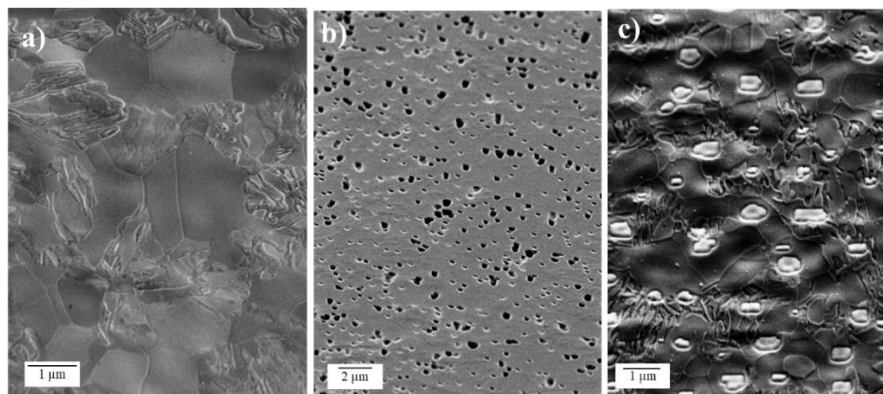


Fig.1 Example Speckle Patterning Techniques (a) Electropolishing (b) FIB hole milling, and (c) Pt deposition

References:

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