Sensing the deep sub-wavelength defects on patterned wafers using cross-polarization scattering imaging

Jiamin Liu[1], Jinlong Zhu[1], Jinsong Zhang[1], Honggang Gu[1], Hao Jiang[1] and Shiyuan Liu[1, 2, #]

1 State Key Laboratory of Intelligent Manufacturing Equipment and Technology, Huazhong University of Science and Technology, Wuhan, 430074, China
2 Optics Valley Laboratory, Wuhan, 430074, China
Corresponding Author / Email: shyliu@hust.edu.cn, TEL: +86-027-87559543, FAX: +86-027-87559543

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With advanced IC processes breaking through sub-14 nm nodes, the processes involved in chip manufacturing become more complex, precise, diverse, and multi-step, which makes random process deviations and environmental pollution extremely prone to occur throughout the IC manufacturing process. Correspondingly, killer defects such as bridging, cutting lines, particles, and holes are also prone to appear in IC nanostructures, affecting IC chips' final performance and yield. In this work, we proposed a polarization far-field microscopy based on a cross-polarization scattering mechanism, making full use of the structural-anisotropy breaking information of defect-contained nanostructures, which allows for high-sensitivity identification and classification of defects in periodically patterned wafers. In the proposed method, the term "cross-polarization scattering imaging" means that a nanoscale defect can perturb the difference between the scattering behaviors of typical periodic nanostructure under two orthogonal polarization illuminations, in which the magnitude and distribution of the perturbation manifested in the far-field difference images will strongly depend on the topological relationship between the defect and the background nanostructure. Simulations realized by a vector imaging model and inspection experiments based on multi-channel cross-polarization scattering-field microscopy have demonstrated that the proposed method can achieve detection sensitivity better than λ/15. This method is thus promising as an online inspection technique for advanced IC manufacturing.