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Concurrent segregation and erosion effects in medium-energy iron beam patterning of silicon surfaces

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Abstract— We have bombarded crystalline silicon targets with a 40 keV Fe+ ion beam at different incidence angles. The resulting surfaces have been characterized by Atomic Force, Current-sensing and Magnetic Force Microscopies, Scanning Electron Microscopy, and X-ray Photoelectron Spectroscopy. We have found that there is a threshold angle smaller than 40º for the formation of ripple patterns, which is definitely lower than those frequently reported for noble gas ion beams. We compare our observations with estimates of the value of the critical angle and of additional basic properties of the patterning process, which are based on a continuum model whose parameters are obtained from binary collision simulations. We have further studied experimentally the ripple structures and measured how the surface slopes change with the ion incidence angle. We explore in particular detail the uence dependence of thepattern for an incidence angle value (40º) close to threshold. Initially, rimmed holes appear randomly scattered on the surface, which evolve into large, bug-like structures. Further increasing the ion uence induces a smooth, rippled background morphology. By means of microscopy techniques, a correlation between the morphology of these structures and their metal content can be unambiguously established.

Index Terms— ion beam sputtering, patterning, silicon, iron silicide, implantation

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