Direct Writing of sub-10 nm Structures from Liquid with Helium Ions

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In-situ direct writing by electron beam from solutions opens a pathway for resistless fabrication of nanostructures at high throughput. However, when using electrons to direct write in solution the minimal size of the created structures is limited to the micron scale due to fundamental physics of the interactions between the electron beam and the liquid, including the lateral transport of solvated electrons and ionic species. Use of the helium beam with the opposite charge and shorter mean free path offers the potential for the localization of the reaction zone on the single digit nanometer scale. Here we will present our results demonstrating writing of platinum structures from liquid (beam induced electroplating) in a platinum chloride solution using helium ions with sub-10 nm resolution. Using data analytics on acquired in-situ growth movies we are able to elucidate the main statistical descriptors for helium ion beam initiated platinum structure growth. The possible mechanisms of beam induced growth and ultrahigh localization of reaction zone are discussed. Furthermore, we will discuss optimization of solution chemistry and instrumental parameters as they relate to the quality and thickness of structures and the extension to device fabrication on a single digit nanometer level.

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