Printing 3-D Nanostructures for Electronics and Sensors Applications

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Abstract

In this work, we developed a directed assembly technique that enables assembly and fusion (printing) of various metallic and semiconductor NPs to fabricate highly organized 3-D crystalline, solid nanostructures on surfaces. In this technique, colloidal NPs are assembled and simultaneously fused (printed) into 3-D nanostructures using an externally applied electric field. Using this method, we fabricated 3-D nanostructures made from gold, copper, aluminum, tungsten and silicon with feature sizes as small as 25 nm in less than a minute at room temperature and pressure without the need for a seed layer and chemical additives. The control of nanostructure dimensions was investigated as a function of many governing parameters such as voltage, frequency, assembly time and particle concentration. Material and electrical characterizations revealed that fabricated gold nanostructures have polycrystalline nature, very low resistivity (1.96×10^{7} Ω m) and demonstrate high optical quality supporting strong plasmonic resonances with line-widths as narrow as 13 nm. This enables highly sensitive plasmonic-based biosensing of proteins. These results indicate that the presented approach will facilitate fabrication of novel 3-D nanomaterials (homogeneous or hybrid) in an aqueous solution at room temperature and pressure, while addressing many of the manufacturing challenges in semiconductor nanoelectronics and nanophotonics.

Short Bio:

Dr. Cihan Yilmaz received his Ph.D. degree in Mechanical and Industrial Engineering at Northeastern University in 2013. His research focused on micro, nano, and molecular scale directed assembly of colloids, and cost-efficient and sustainable additive manufacturing of functional nanostructures for electronics, energy, and biomedical applications. Dr. Yilmaz has authored or coauthored 15 papers and 10 patents in the field, and presented his findings in more than 50 conferences.

Dr. Yilmaz is currently working as an Innovation Engineer at Flex Boston Innovation Center, where he will be working on developing next generation products in the areas of healthcare, electronics and energy.