

## Fabrication of nano-/micro bismuth droplets and the effect of laser irradiation on morphology and Raman scattering properties

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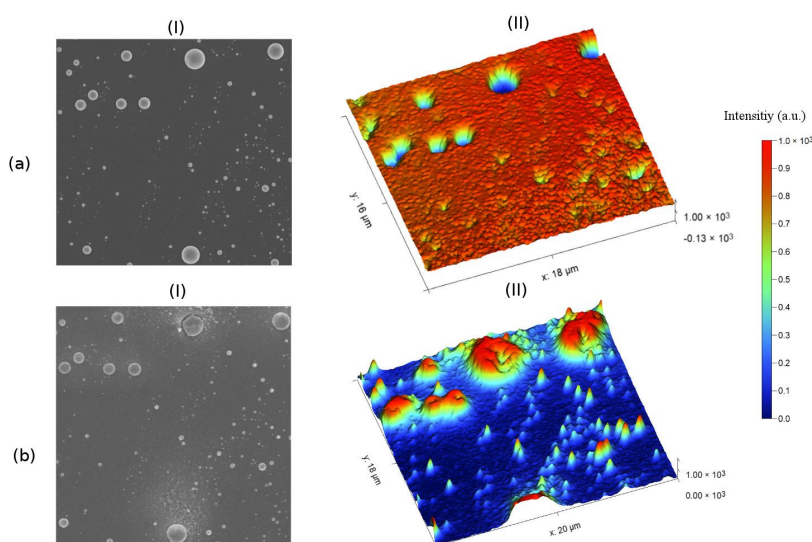
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### Abstract

Semimetals are recently showing to be promising materials in photonics and plasmonics, with a wide range of possible applications from sensing to photocatalysis. Bismuth (Bi) is a semimetal of growing interest, and it has unusual properties compared to conventional metals, such as an unique band structure, small effective mass, low carrier density, and long mean free path. In our work we investigated Raman scattering from Bi droplets.

Crystalline nano-/micrometer sized Bi droplets were fabricated from epitaxially grown Bi thin films in ultra high vacuum on silicon Si(111) substrate. The quality of thin film and confirmation of droplet formation was verified by reflection high energy electron diffraction. An area of the sample was selected and subjected to high power laser irradiation. Characterization of the Bi droplets before and after laser exposure was done by scanning electron microscopy (SEM), atomic force microscopy (AFM) and Raman spectroscopy mapping. The Bi droplets show a modulation of the Raman scattering intensity from silicon phonons after being exposed to high power laser irradiation. From the Raman spectroscopy data, shown in Figure 1 (a) (II), the Si 520 1/cm peak at the position of Bi droplets is lower than substrate background, however after laser exposure (b) (II), Si peak is enhanced by a factor of about 1.2-1.6 compared to the background. To our knowledge, this is the first time such phenomenon is reported by a semimetal. The mechanism of modulation and enhancement of the Si phonon is not yet fully understood. However, suggestively contributing factors are the droplets have an altered morphology, as observed by SEM and AFM, when subjected to laser. Also, surface oxidation occurs, which was detected by the emergence of  $\beta$ -Bi<sub>2</sub>O<sub>3</sub> vibrations in the Raman spectrum.



**Figure 1. Effect of laser exposure on Bi droplets.** SEM image of Bi droplets (I) and Si 520 1/cm Raman mapping (II) before (a) and after (b) laser exposure. Images are obtained from the same area.