Nanoscale amorphization of $Ge_2Sb_2Te_5$ by laser-driven STM

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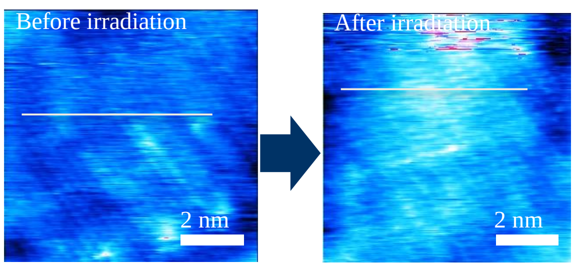
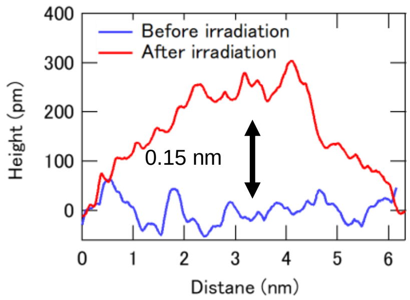
$Ge_2Sb_2Te_5$, which is a layered chalcogenide, is attracting attention for its topological band structure[1] and its light-induced phase change which is applied to memory devices. Crystal $Ge_2Sb_2Te_5$ can be thermally transformed into amorphous phase via liquid phase by laser irradiation. In conventional optical storage devices, the recording capacity is limited by the diffraction limit of light. Recent study[2] shows that the size and the positional uncertainty of amorphous marks can be reduced below the diffraction limit by concentrating the heat, e.g. by applying voltage pulses from the tip of a scanning probe microscope[3]. However, the heat generated by voltage pulses often damage the tip apex. In our previous report, we showed that $Ge_2Sb_2Te_5$ can be amorphized non-thermally by femtosecond laser irradiation.[4] In the present study, we demonstrate that the near-field light generated by focusing femtosecond laser pulses onto the scanning tunneling microscope (STM) tip can be utilized for writing few-nanometer-sized amorphous marks on $Ge_2Sb_2Te_5$ surfaces with nanometer spatial accuracy.

The figures show the change of the STM topo image and the line profile by laser irradiation. A mound with the diameter of 6 nm was formed by laser irradiation. The differential conductance (dI/dV) spectra show that the band gap is wider on the mound, which indicates that the mound is an amorphous region. We also demonstrated that the amorphous region could be detected by dI/dV mapping, which is expected to be a more suitable detection method than the conventional topo images due to its robustness against the surface roughness.

Topo image



Line profile



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