Study of magnetic nanoparticles obtained by Laser ablation of Mount Etna volcanic rocks

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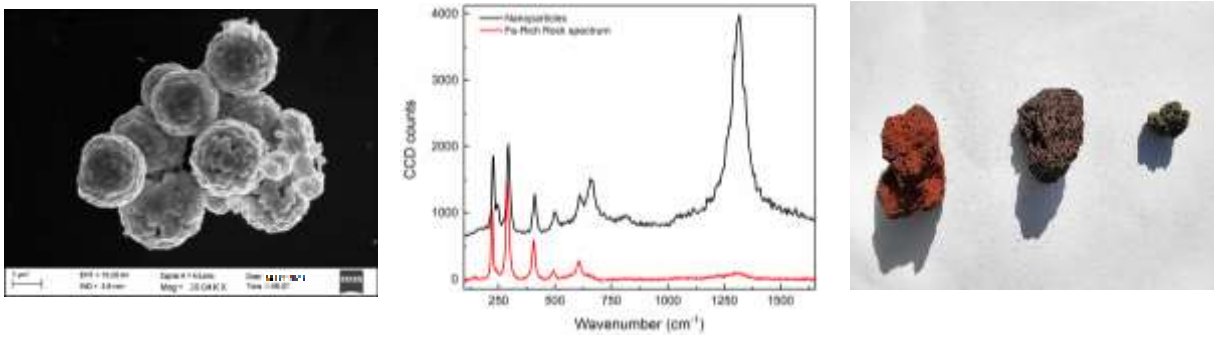
Mount Etna, Europe's tallest and most active volcano, annually releases vast amounts of magmatic material down its slopes. This magma, upon cooling, forms rocks containing a variety of metals such as Fe, Co, Vn, Cu, Zn, Si, as well as non-metals like S and B [1]. Traditional methods struggle to extract these elements due to the mechanical properties of volcanic rock. In our research, we utilize Laser Ablation to directly extract metals from volcanic rock, creating Metallic nanoparticles with magnetic and rough characteristics. Before ablating, three volcanic rocks (Fig. 1c) underwent analysis via Raman spectroscopy and Laser-induced Breakdown Spectroscopy (LIBS) to determine their elemental composition. The resulting nanostructures from Pulsed Laser Ablation in Liquids (PLAL) exhibit diverse characteristics depending on the starting rock's composition. We extensively characterized these nanostructures using Scanning Electron Microscopy (SEM), UV-VIS spectroscopy, and Raman spectroscopy (Fig. 1a, 1b). Notably, the nanostructure from the iron-rich rock predominantly consists of Cobalt-hematite (α-Fe2O3) [2], displaying magnetic properties (Fig. 1b). These findings highlight our ability to easily obtain magnetic nanostructures from a readily available source. Moreover, these nanostructures can be functionalized with noble metal nanostructures as Surface-enhanced Raman Spectroscopy (SERS) substrates [3], or with organic molecules for nanomedicine applications.



(a) (b) (c)

Figure 1. (a) SEM image of hematite nanoparticle obtained from Fe-rich rock, (b) Raman spectrum of the obtained nanostructure compared with that of the bulk rock. (c) The three rocks studied.

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[3] Chen, Juhong, et al. "Highly sensitive and selective detection of nitrite ions using Fe3O4@ SiO2/Au magnetic nanoparticles by surface-enhanced Raman spectroscopy." *Biosensors and Bioelectronics* 85 (2016): 726-733.