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Fiber Bragg grating sensors for strain changes measurements at volcanic sites (MED-SUV project; WP 2; Sub-Task 2.2.2)

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Stress and strain changes at volcanic areas are recognized among the best indicators of changes in the activity of the system, and its possible evolution towards critical stages. Depending on their time evolution, stress and strain changes have been the focus of either geodetic (static changes) or seismological (dynamical changes) studies.
In volcano geodesy, encouraging results have been obtained though borehole strain-meters. However, they are not easy to install and involve high costs. Therefore, the near future of strain observations at volcanoes depends on the development of broad-band sensors which are low-cost and easy to install, even in the form of dense arrays.
Advancements in opto-electronics have allowed the development of low-cost sensors, reliable, rugged and compact, which are particularly suitable for on-field application.
In the framework of WP 2 (New monitoring and Observing systems) of the MED-SUV project, the sub-task 2.2 involves the development of strain sensors based on the fiber Bragg grating (FBG) technology. In comparison with previous implementation of the FBG technology to study rock deformations, the system that is being developed within MED-SUV is expected to offer a significantly higher resolution and accuracy in static measurements. Moreover, a careful study is being carried out in order to obtain a smooth dynamic response up to 100 Hz, thus allowing the observation of seismic waves. Finally, the system under development will allow multi-axial strain sensing. The system performances are tailored to suit the requirements of volcano monitoring, with special attention to the trade-off between resolution and cost, and with special care to power consumption.
Here we present the results of a field campaign with a preliminary, single-axis FBG strain sensor prototype on Etna, which was carried out in order to check the system performances in out-of-the-lab conditions and in the hostile volcanic environment (lack of mains electricity for power, strong diurnal temperature changes, strong wind, erosive ash, snow and ice during the winter time), and to determine whether measurable changes are induced across a 1989 fracture system during the paroxysmal phases of Etna's volcanic activity. In addition we present the design and laboratory test of a multi-axial strain sensor configuration.