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Fiber Bragg grating strain sensors to monitor and study active volcanoes

Fiodor Sorrentino (1,2), Nicolò Beverini (3), Daniele Carbone (4), Giorgio Carelli (1,3), Francesco Francesconi (1,3), Salvo Gambino (4), Umberto Giacomelli (3), Renzo Grassi (1), Enrico Maccioni (3), Mauro Morganti (5,6)

(1) Marwan Technology, Pisa, Italy (sorrentino@marwan-technology.com), (2) Istituto Nazionale di Fisica Nucleare, Sezione di Genova, Genova, Italy, (3) Dipartimento di Fisica, Università di Pisa, Pisa, Italy, (4) INGV - Osservatorio Etneo - Sezione di Catania, Catania, Italy , (5) Istituto Nazionale di Fisica Nucleare, Sezione di Pisa, Pisa, Italy, (6) Accademia Navale di Livorno, Livorno, Italy

Stress and strain changes are among the best indicators of impending volcanic activity. In volcano geodesy, borehole volumetric strain-meters are mostly utilized. However, they are not easy to install and involve high implementation costs.
Advancements in opto-electronics have allowed the development of low-cost sensors, reliable, rugged and compact, thus particularly suitable for field application. In the framework of the EC FP7 MED-SUV project, we have developed strain sensors based on the fiber Bragg grating (FBG) technology. In comparison with previous implementation of the FBG technology to study rock deformations, we have designed a system that is expected to offer a significantly higher resolution and accuracy in static measurements and a smooth dynamic response up to 100 Hz, implying the possibility to observe seismic waves. The system performances are tailored to suit the requirements of volcano monitoring, with special attention to power consumption and to the trade-off between performance and cost.
Preliminary field campaigns were carried out on Mt. Etna (Italy) using a prototypal single-axis FBG strain sensor, to check the system performances in out-of-the-lab conditions and in the harsh volcanic environment (lack of mains electricity for power, strong diurnal temperature changes, strong wind, erosive ash, snow and ice during the winter time).
We also designed and built a FBG strain sensor featuring a multi-axial configuration which was tested and calibrated in the laboratory. This instrument is suitable for borehole installation and will be tested on Etna soon.