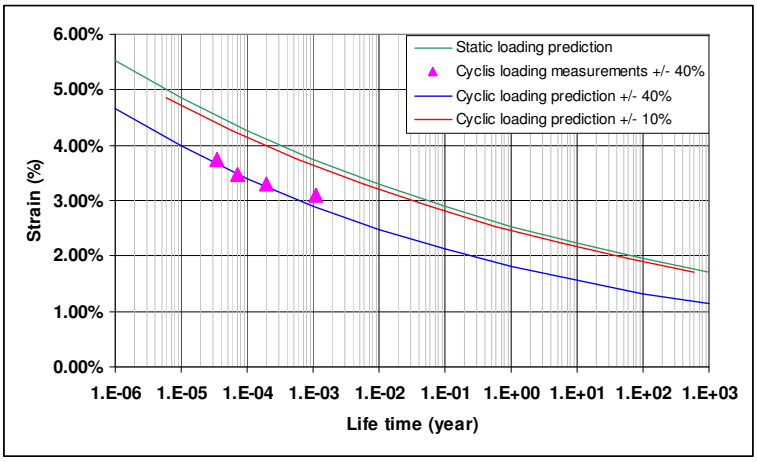
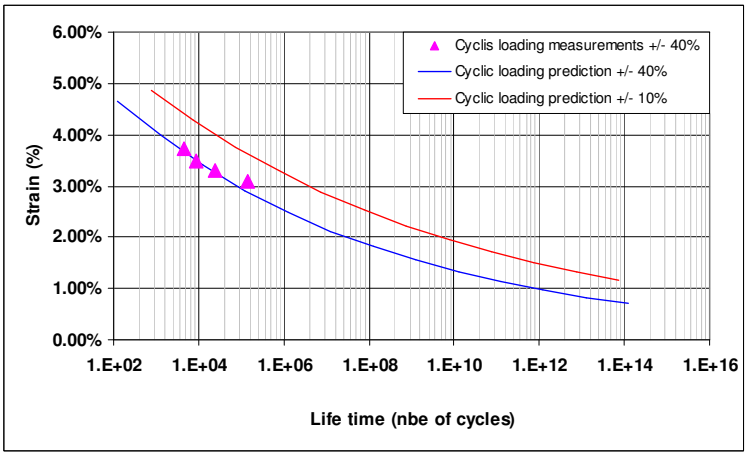
Bragg grating resistance to fatigue

Optical fibers and Bragg gratings exhibit a very long lifetime under static and cyclic loading.

Tests on optical fibers and Bragg grating have been reported in the literature [1], lifetime predictions were measured and estimated from actual tests and theoretical calculations:
It appears that the lifetime of Bragg gratings under constant loading is in the order of 50 years at 2% strain (green curve)



Under cyclic **loading at 4Hz**, with an amplitude of +/-10% (red curve) around this mean strain (1.9%-2.1%), lifetime remains 30 years. This high strain is never observed in most of the sensor applications, in particular on composite, meaning that the life time of Bragg grating is quite indefinite under 1% strain, even in case of high cyclic amplitude of +/-40% (0.6%-1.4%) (blue curve), where the predicted lifetime is longer than 1'000 years!.

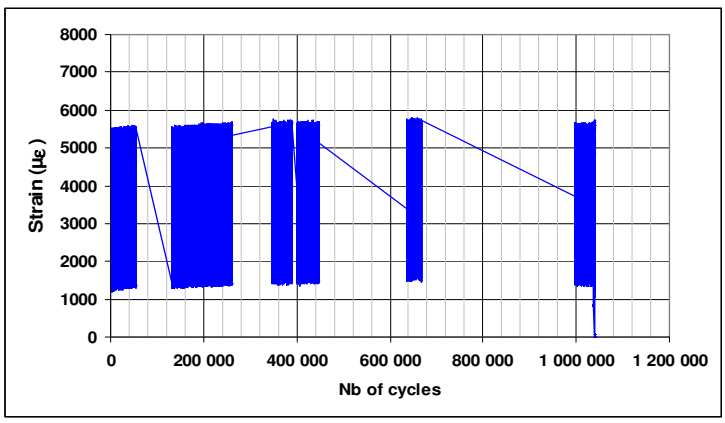


These values can be expressed in number of cycles, which is more representative of the fatigue behavior of materials, since the resistance to fatigue depends upon the number of cycles, whatever the frequency of solllicitation.
Life time is therefore 10^{12} cycles at 1% +/- 40% and 10^{14} at 0.7% +/- 40%.

However the major problems in using fiber Bragg grating as sensor concern the protection of the fiber against environment and the transfer of load between the structure and the sensor. SCAIME's ADVOPTICS range of sensors overcome this limitation thanks to its unique packaging technique.

SCAIME strain sensors resistance to cyclic fatigue

High resistance to cyclic fatigue of the SCAIME sensors



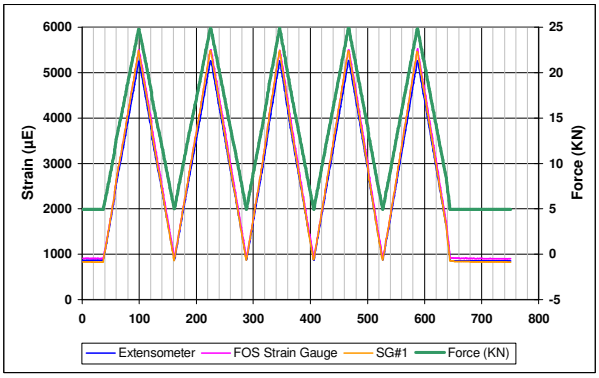
One million cycles fatigue testing of a **SCAIME** sensor between 1'400 and 5'700 με at 2.5 Hz, without degradation of its properties.

[1] Lifetime of fiber Bragg grating under cyclic fatigue – P.Mauron, Ph.M. Nellen and al - EMPA. Conference on optical fiber reliability and testing, Boston, Massachusetts, USA 19-22 September 1999

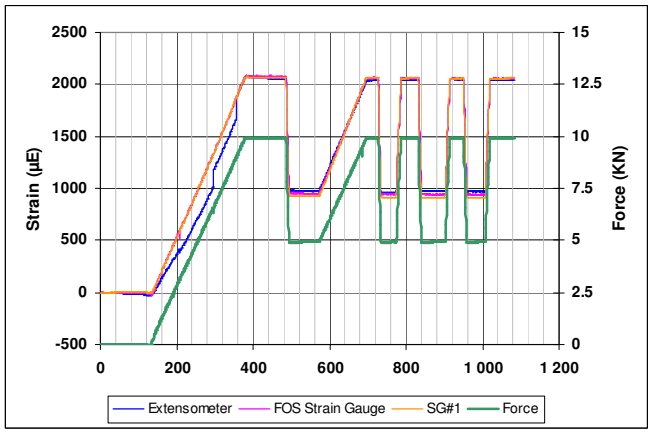
SCAIME strain sensors on the structure

Thanks to a strong know-how and expertise in adhesive bonding and material sciences, the load transfer between the ADVOPTICS sensors and the structure to be tested is fully mastered.

Tensile test on a composite specimen equipped with an adhesively bonded **SCAIME** strain sensor, a classical thin film strain gauge (SG#1) and an extensometer.
Loading and unloading cycles between 5 to 10 KN (1'000 to 2'000 με)

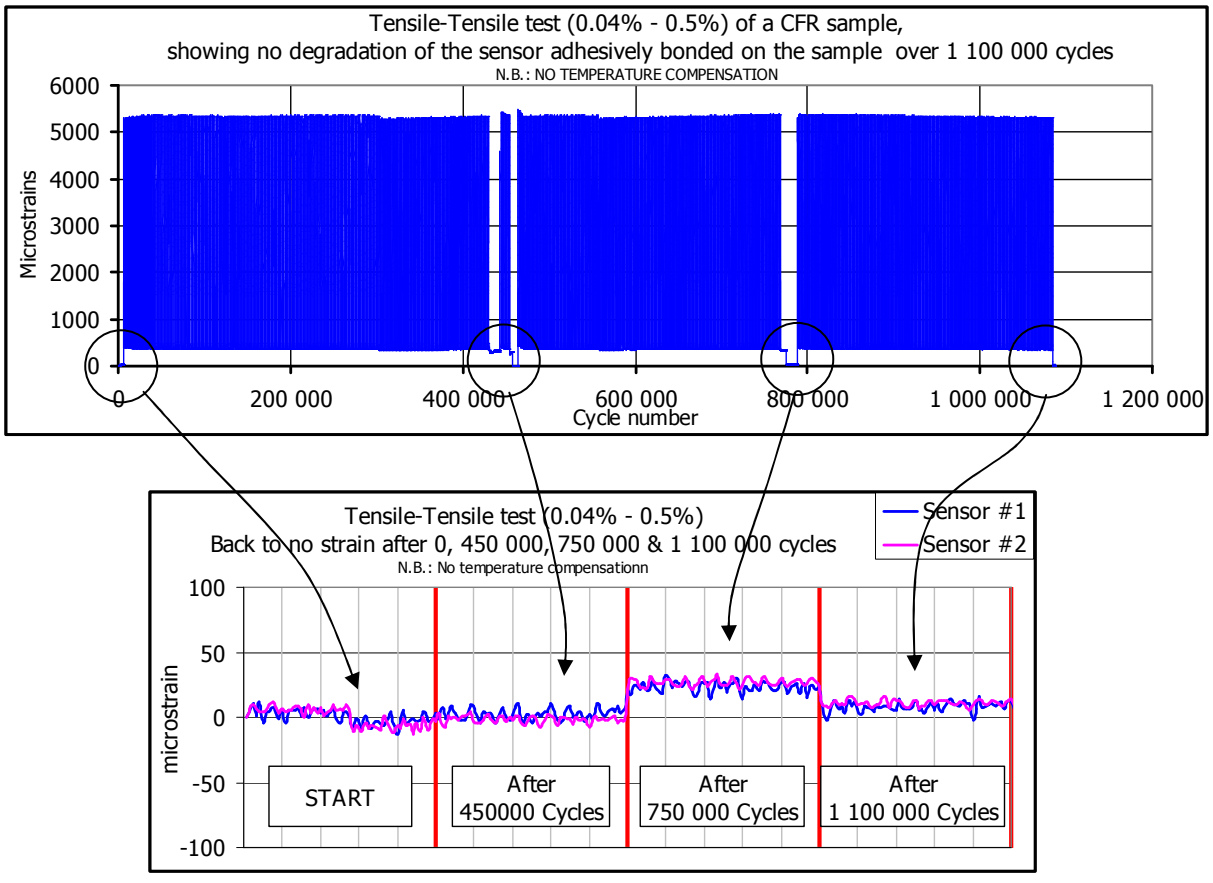


High load cycles (up to 25 KN – 5'500 με)



High resistance to cyclic fatigue of the sensors adhesively bounded on a structure

Two **SCAIME** sensors were adhesively bounded on a Carbon Fiber Reinforced Plastic composite strip for a 1'100'000 cycles fatigue test at 1 Hz, between 0.04 % and 0.55%.



After unloading strain is back to the initial position