Fiber Bragg Grating Sensors (FBGs)

Prof. Dr. Wolfgang Schade

Fraunhofer Heinrich-Hertz-Institut, Außenstelle EnergieCampus Goslar
Am Stollen 19, 38640 Goslar

FBGs: Wind Power Plant Monitoring

Sensors for enhanced energy efficiency

Sensors for testing new blade designs

FBGs: Wind Power Plant Monitoring

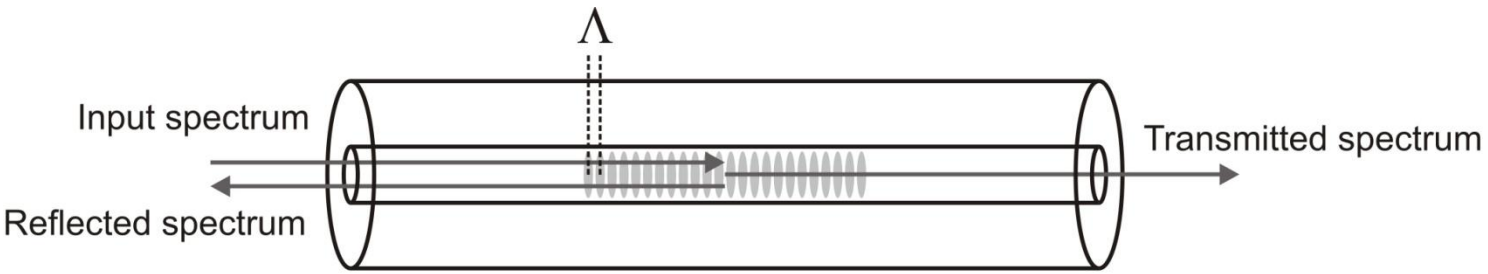
What?

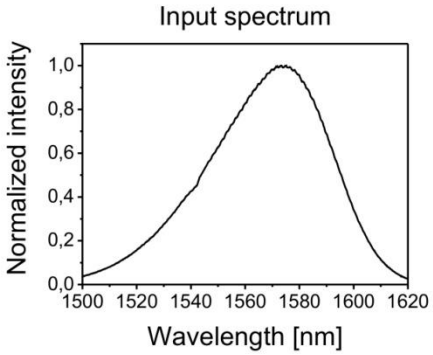
- structural health monitoring
- 3D-load and strain monitoring
- detection of blade icing
- active pitch control

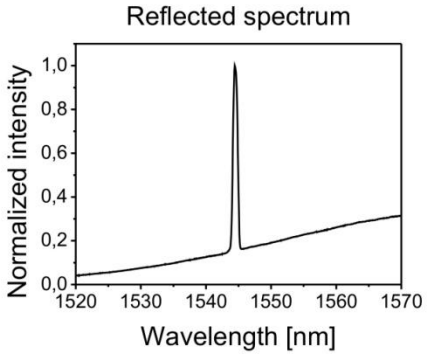
Why fiber optical sensors?

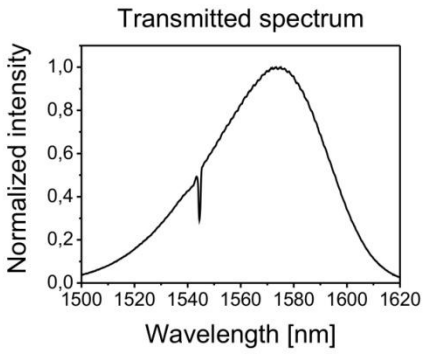
- not effected by electromagnetic field
- sensor networks
- easy to install and low costs

Fiber Bragg Grating Sensor - concept









Bragg condition

$$\lambda_B = 2n_{eff}\Lambda$$

Λ: grating period
n_{eff}: effective refractive index

FBG sensors – our concept

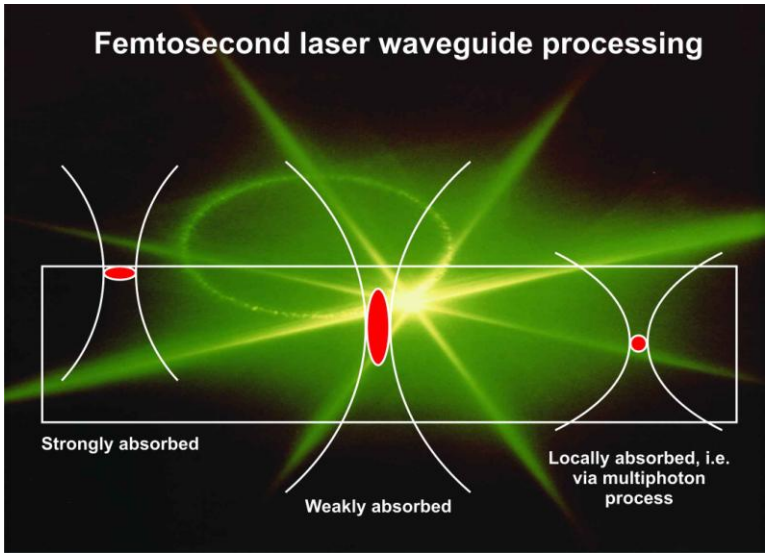
What?

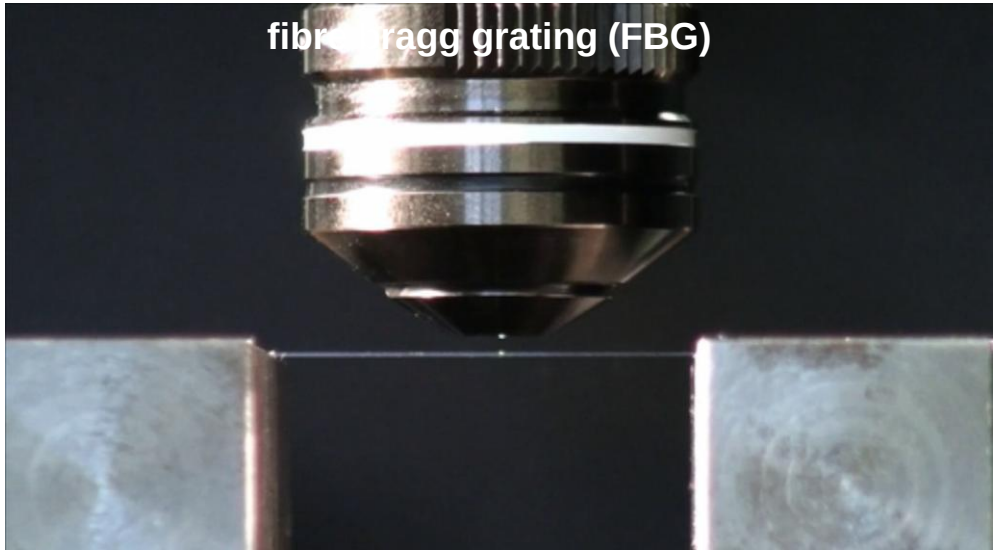
- miniaturization
- low energy consumption
- less weight
- low costs
- mass production

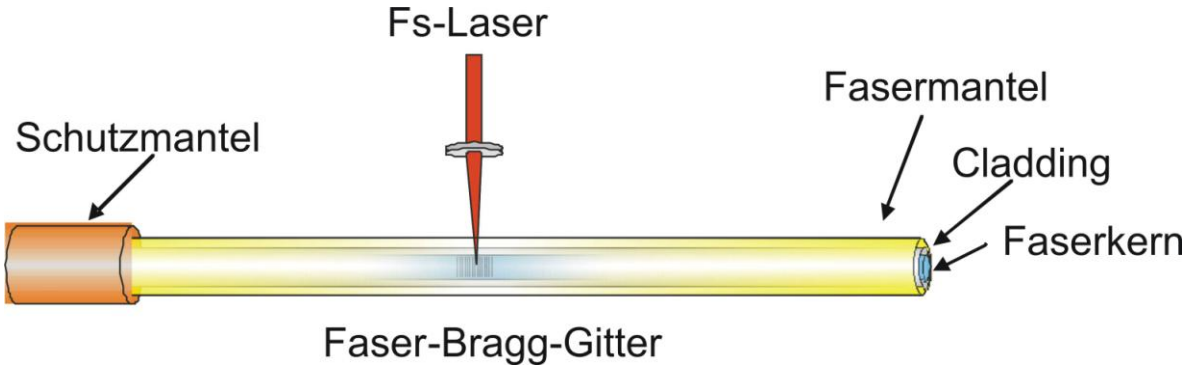
How?

- telecom components (1.5 µm)
- silicon chip wafer technology

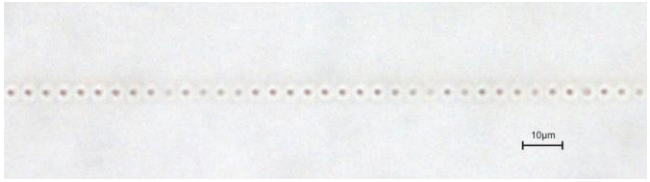
Femtosecond Laser FBG Processing





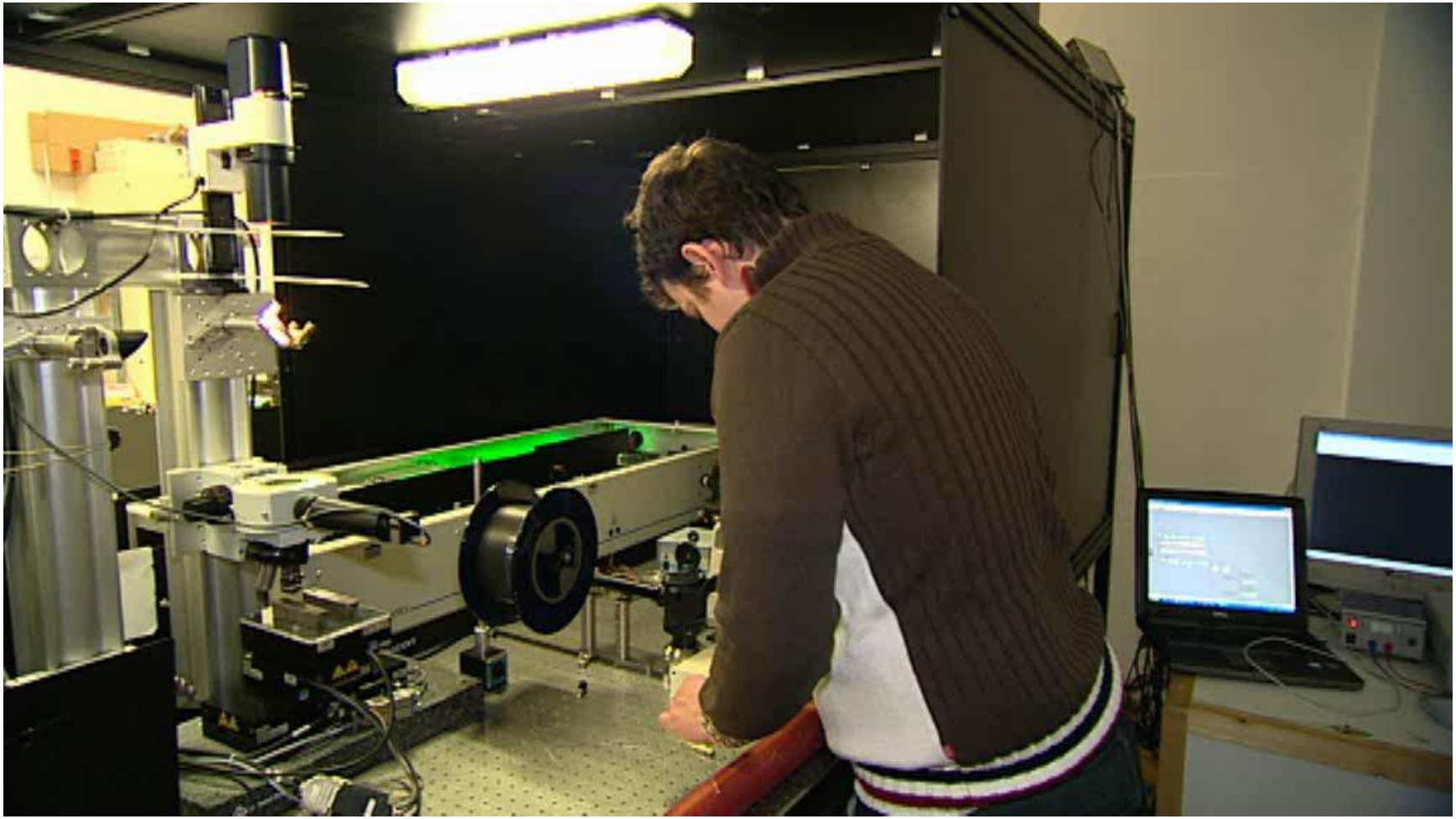


Fiber Bragg Grating



Femtosecond Laser FBG Processing

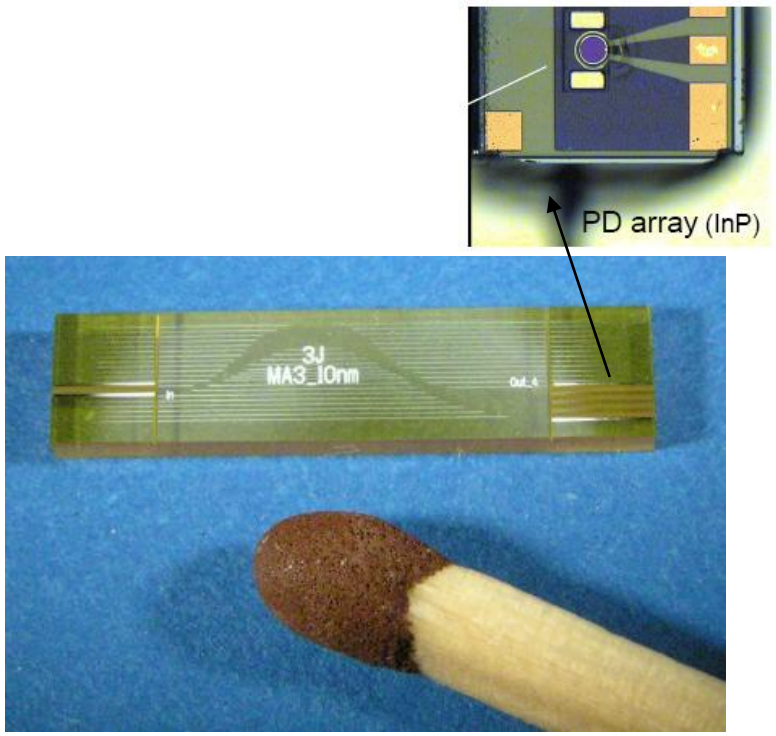
Fibre Optical
Sensor Systems

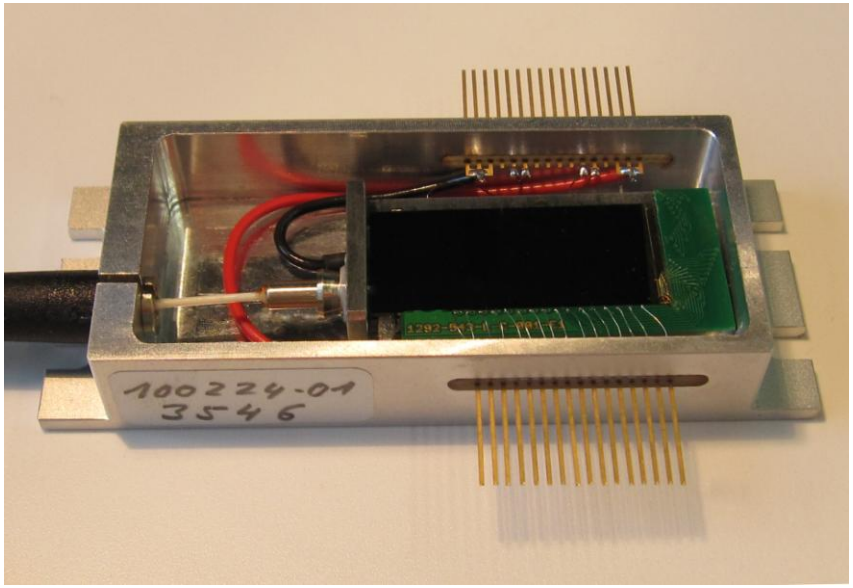


Draka

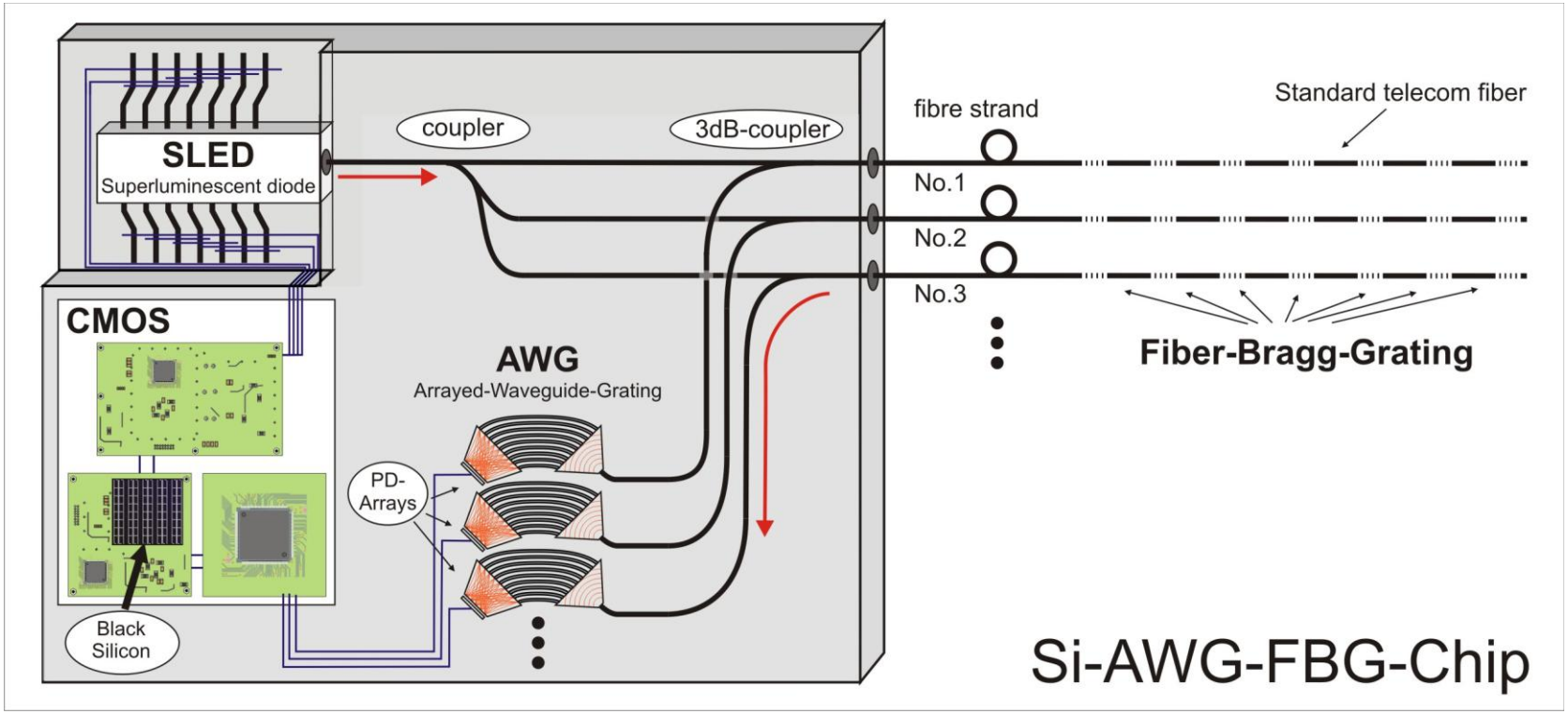
Miniaturized FBG Interogator System

Polymer based arrayed waveguide (AWG) chip spectrometer





Lab on a Chip Design



FBG Condition Monitoring

Bundesministerium
für Umwelt, Naturschutz
und Reaktorsicherheit

FBG sensors – what can be measured?

FBG sensor specifications

- temperature	$\Delta T < 0.1$ K
- strain	$\varepsilon < 25$ µm/m
- vibration	$\Delta v < 0.1$ Hz
- frequencies	1 Hz … 500 kHz
- 3D profiles	$\Delta x,y,z < 1$ mm
- acceleration	$\Delta a < 0.1$ … 0.01g