UNIVERSITÀ DEGLI STUDI DI BERGAMO

INTERNATIONAL CAE CONFERENCE

Numerical Methods for a Crack Rate Propagation Model in PVD Coated High Performance Spur Gears

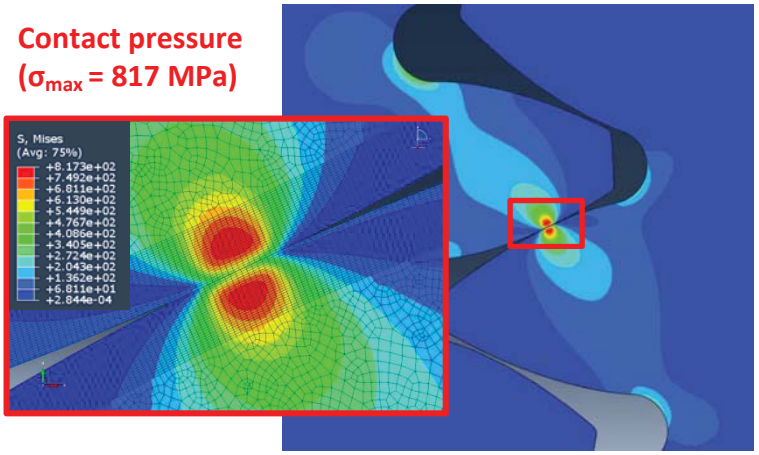
Sergio Baragetti[1,2], Michele Pardo[1]

[1] Department of Management, Information and Production Engineering,
University of Bergamo, Viale Marconi 5, Dalmine 24044, Italy
[2] GITT – Centre on Innovation Management and Technology Transfer
University of Bergamo, Via Salvecchio 19, Bergamo 24129, Italy

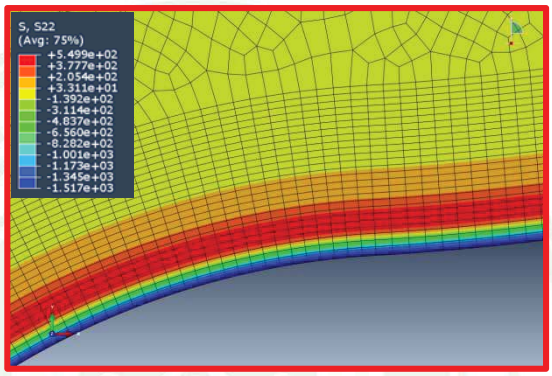
Abstract

The PVD (Physical Vapor Deposition) coating is one of the surface processes used to improve mechanical properties in engineering applications. Based on a linear, plane strain, elastic FE model of high performance spur gears, residual stresses produced by WC/C coating and pressure between the flanks of teeth during the contact have been simulated. Therefore a propagation model has been implemented to predict the crack propagation for the coated elements, comparing stress the intensity factor range with the threshold stress intensity factor, defined by using the theoretical models of El-Haddad, Murakami-Endo and LEFM (Baragetti S., Int. J. Fatigue, 2007). The outcomes for the coated spur gears were compared with the uncoated ones to underline effective increments in fatigue resistance.

Contact pressure (σ_{max} = 817 MPa)



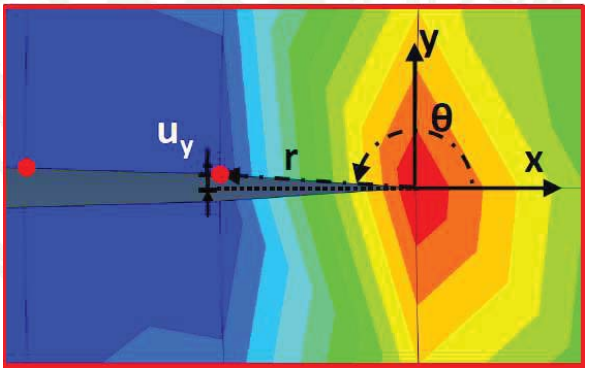
Residual stresses (parallel to external surface)



➢ Stress intensity factor:

$$K_I(r,\theta) = \frac{2E}{1+\nu} \cdot \sqrt{\left(\frac{2 \cdot \pi}{r}\right)} \cdot \frac{u_y}{f(\theta)}$$

- FE model: linear plane strain 2D elements
- Initial crack length: **5 µm**
- 3 µm WC/C coating



	Crack length (µm)	ΔK_I (MPa·√m)	ΔK_{th} (MPa·√m)
UNCOATED	10	2.38	2.25
	20	2.98	2.76
	50	4.46	4.28
	100	5.91	5.39
	200	7.19	6.79

	Crack length (µm)	ΔK_I (MPa·√m)	ΔK_{th} (MPa·√m)
COATED	10	0	2.52
	20	1.29	3.02
	30	3.18	3.58
	40	6.92	4.07
	50	9.43	4.36
	100	13.68	5.44
	200	15.97	6.82