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PROGRAM BOOK

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1-9 - Modeling of Fracture in Hard and Sof materials

Evening Session

DAY: Tuesday

ROOM: Ciano B

TIME 17.00-19.00

CHAIR: Roberta Massabò, Konstantin Volokh

1188 **Damage in elastomers: Nucleation, growth and healing of cavities, and micro-cracks**

Authors: Ravi-Chandar Krishnaswamy

Presenting Author: Ravi-Chandran Krishnaswarny

1284 **A 3D cohesive interface for the delamination analysis of a stiff film on a soft elastic substrate and the wrinkling/buckling deformation modes**

Authors: Guido Borino, Francesco Parrinello

Presenting Author: Guido Borino

242 **Fracture as material sink**

Authors: Konstantin Volokh

Presenting Author: Konstantin Volokh

332 **Effect of Solvent Diffusion on the Crack Velocity in a Reversible Hydrogel**

Authors: Olivier Ronsin, Imen Naassaoui, Tristan Baumberger

Presenting Author: Tristan Baumberger

652 **Supershear Propagation of Frictional Rupture Fronts**

Authors: David Kammer

Presenting Author: David Kammer

A 3D cohesive interface for the delamination analysis of a stiff film on a soft elastic substrate and the wrinkling/buckling deformation modes

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Keywords: surface wrinkling, cohesive interface, large deformation

The paper proposes a finite element systematic study of a mechanical system composed by a soft elastic substrate, subjected to a uniform state of compression, covered by a stiff thin film. This kind of problem is rather common for coating systems where layered materials with severe mismatch of elastic and thermal properties are largely employed. The specific mechanical problem stands on the concomitant competition between elastic wrinkling surface deformation and the nonlinear delamination that can develop at the interface between the thin film and the substrate. Both mechanical phenomena have their source in the nonlinear elastic buckling of the thin stiff film, which can be viewed as a thin bending plate on a soft elastic foundation. Beside the elastic instability which produce wrinkling a further material nonlinear phenomena may develop, which is the delamination of the thin film in a buckled configuration with respect to substrate.

Because of the relevance in the new small scale technologies, this problem has been intensively analyzed in recent years either by analytic approaches or by numerical analysis [1, 2, 3].

In this contribution the problem is faced by numerical approach and a recently proposed cohesive interface model in large displacement regime [4] is extended to 3D problems and therefore applied for a complete finite element nonlinear analysis. The numerical simulations are performed exploring the post elastic buckling conditions, the formation and the subsequent interface crack propagation, which in turns produces surface bubbles. For 3D problems in which the interface is a plane surface the wrinkling and the bubble surface can assume very complex patterns.

Analysis will be also reported for thin films with initial defects, or pre-exiting small cracks, at the adhesive interface film-substrate. Finally a discussion of the overall response will be reported.

References

[1] *Mei, H., Landis, C., and Huang, R., "Concomitant wrinkling and buckle delamination of elastic thin films on compliant substrates", Mechanics of Materials,* **43** *(11), 627–642, (2011).*

[2] *Pan, K., Ni, Y, He, L., and Huang, R., "Nonlinear analysis of compressed elastic thin films on elastic substrates: From wrinkling to buckle-delamination", International Journal of Solids and Structures,* **51** *(21), 3715–3726, (2014).*

[3] *Reinoso, J., Paggi, M. and Rolfes, R., "A computational framework for the interplay between delamination and wrinkling in functionally graded thermal barrier coatings", Computational Materials Science,* **116***, 82–95, (2016).*

[4] *Parrinello, F., and Borino, G., "Integration of finite displacement interface element in reference and current configurations", Meccanica, (in press), https://doi.org/10.1007/s11012-017-0804-0, (2017).*