Dr. María Jesús Lamela Rey

STRUCTURAL MECHANICS DIVISION

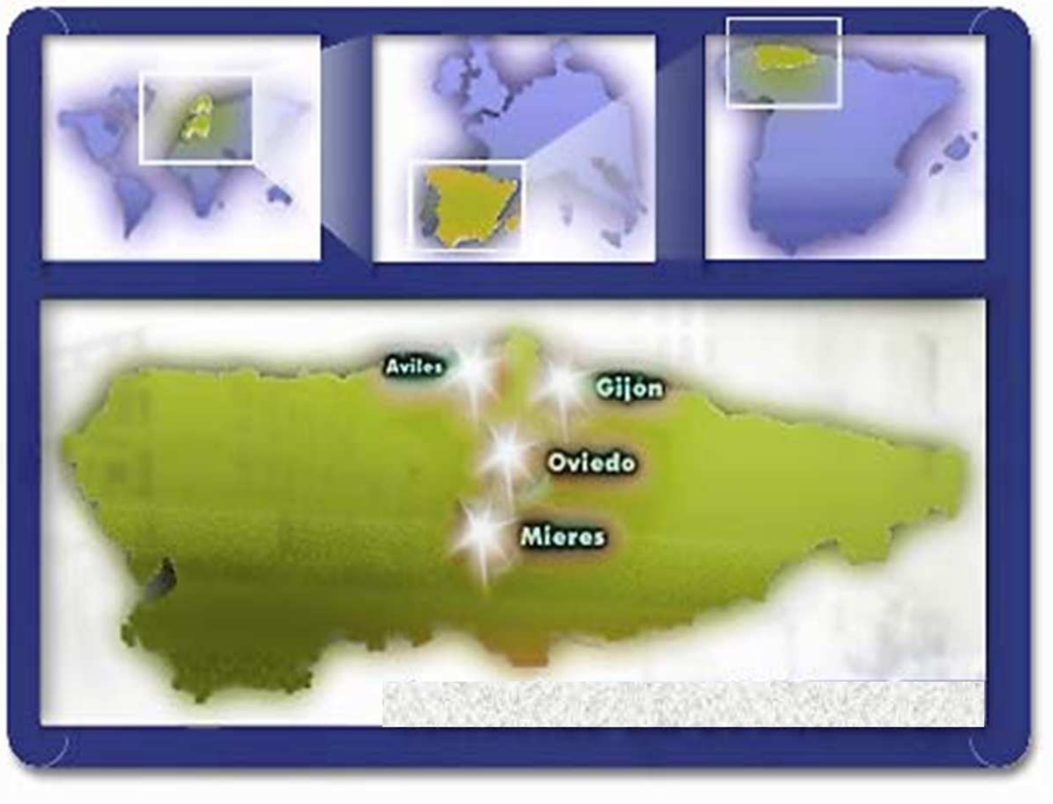
DEPT. CONSTRUCTION AND MANUFACTURING ENG.

FACULTY OF ENGINEERING OF GIJÓN

UNIVERSITY OF OVIEDO. SPAIN

University of Oviedo

- The University of Oviedo is an institution with more than **400 years** of history. It was founded in 1579, but its courses started in 1608.
- More than 30.000 students and 3.000 academic staff distributed in three city campuses (**Oviedo, Gijón and Mieres**),
- It offers **academic programs** in all branches of knowledge



CAMPUS DE EXCELENCIA INTERNACIONAL
Universidad de Oviedo

- **All degrees have been adapted to the European Higher Education Area**
- **The University has done a reorganization of faculties and schools to create great research and teaching centres**

Faculties

Biology
Sciences
Law
Economy and Business
Arts
Education and Teacher Training
Geology
Medicine and Health Sciences
Psichology
Chemistry
Commerce, Tourism and Social Sciences

Higher Technical Schools

Polytechnic School of Engineering of Gijón (Faculty of Engineering)
Polytechnic School of Mieres
Polytechnic School of Mining Eng.
Nautical School

Professional Schools

Sports Medicine and Physical Education
Computer Engineering

CAMPUS DE EXCELENCIA INTERNACIONAL
Universidad de Oviedo

Oviedo University International Offers:

- Bilingual degrees
- International Masters' degrees
- Agreements with more than 40 countries
- Every year 1,300 grants for study or work placements in more than 400 universities

Faculty of Engineering
Campus de Viesques. Gijón

Engineering Bachelors:

- Chemical
- Industrial Technologies
- Mechanical (Construction and Mechanical Design)
- Electrical
- Electronics and Automatics
- Computer Sciences and Information Technologies
- Tecnology and Telecommunication Services

Engineering Masters:

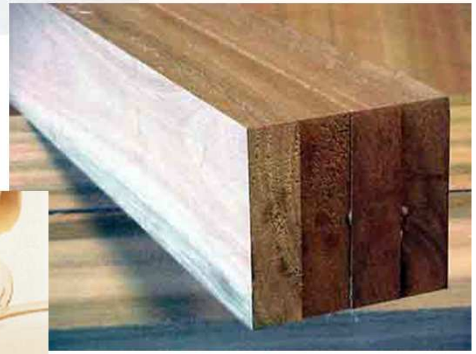
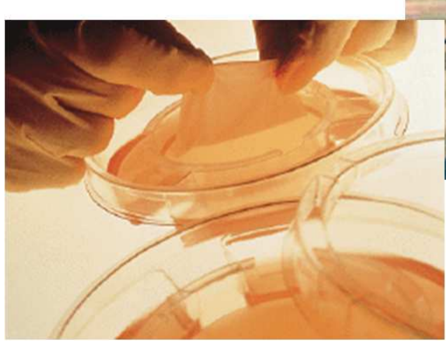
- Mechatronics and Micro-Mechatronics Systems (Erasmus Mundus Master)
- Sustainable Transportation and Electrical Power Systems (Erasmus Mundus Master)
- Management of Industrial Design (UPV-UO)
- Energy (UO)


LOCATION

STRUCTURAL MECHANICS DIVISION
DEPT. CONSTRUCTION AND MANUFACTURING ENGINEERING
FACULTY OF ENGINEERING OF GIJÓN
UNIVERSITY OF OVIEDO

Structural Mechanics Division Research Lines:

- Characterization of materials
- Fatigue
- Fracture mechanics
- Probabilistic models
- Biomechanics
- Modal analysis

PROBABILISTIC DESIGN MODEL FOR LAMINATED GLASS

1. Introduction

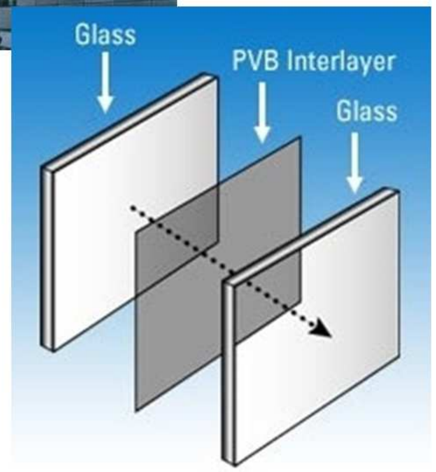
Research Project Glass, PN 2005-2008 (EPSIG-UO & ETSII-US)

Research Project Glass, PN 2012-2014 (EPIG-UO & ETSII-UPM)

- The aim of this research consists of developing a design methodology for monolithic and laminated glass, particularly glazing plates, proposing a new design code for structural glass in Spain.

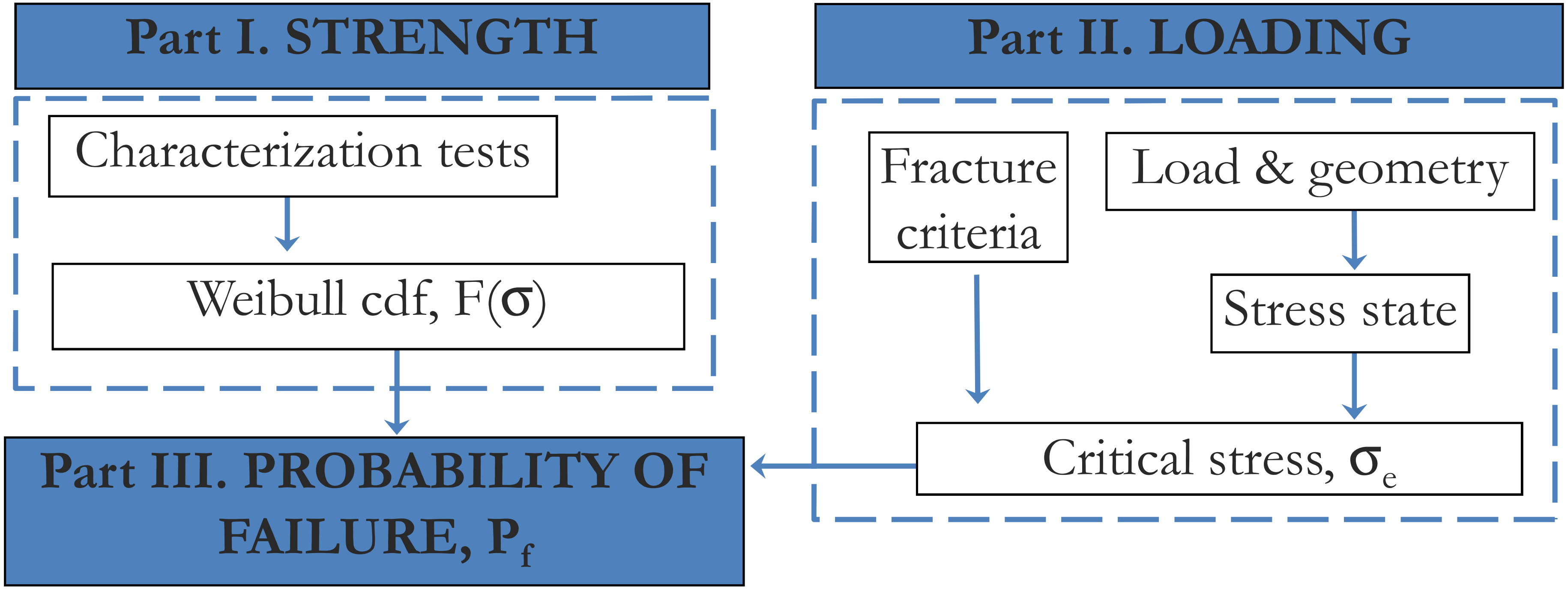
- Due to its brittle nature, glass requires rigorous design methods, since its resistance is very much dependent on surface microcraks, element size and loading pattern.

- The design model proposed is developed on the basis of the non-linear plate theory and the elastic and viscoelastic material behaviour of constituents, together with fracture mechanics criteria and probabilistic considerations.



2. Description of the design model

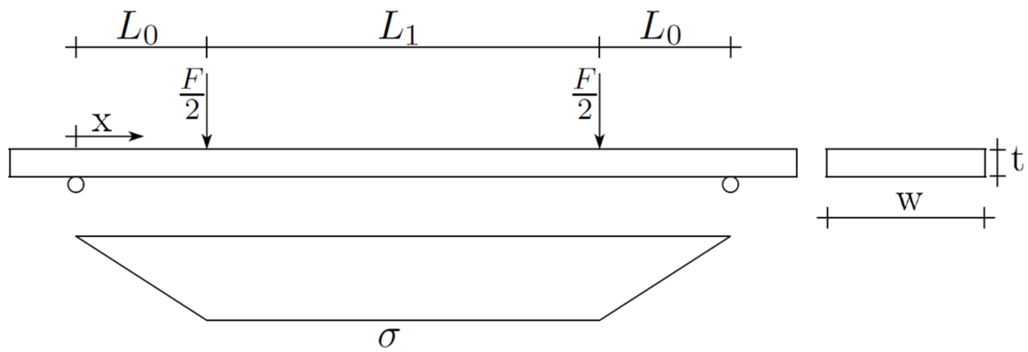
- **Stress model (critical stress)**

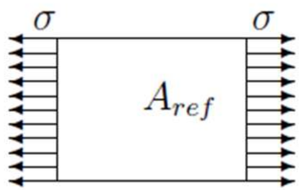


2. Description of design model

Part I. Strength: Glass characterization

The characterization of glass can be expressed by the cdf of σ from 4-P bending tests, assuming a 3-parameter Weibull distribution and an area of reference (A_{ref})





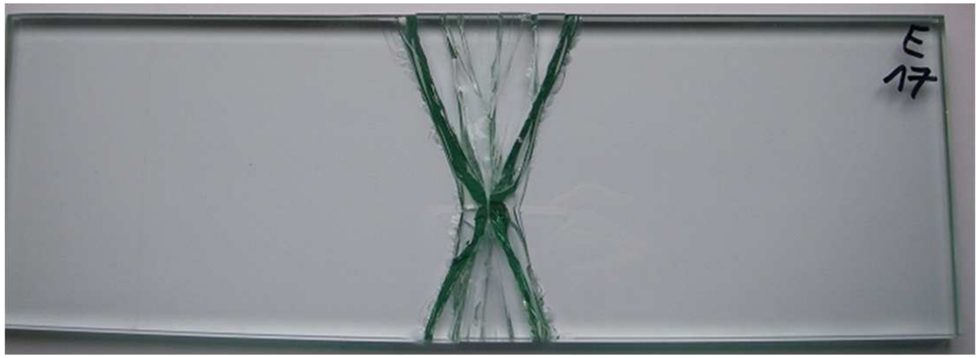
$$A_{ref} = w\left[\frac{2L_0}{(\beta+1)}\left(1-\frac{\lambda}{\sigma}\right)+L_1\right]$$

$$F(\sigma) = P_{f,A_{ref}}(\sigma) = 1-\exp\left[-\left(\frac{\sigma-\lambda}{\delta}\right)^{\beta}\right]; \sigma \geq \lambda$$

$$P_{f,A_i}(\sigma) = 1-\exp\left[-\frac{A_i}{A_{ref}}\left(\frac{\sigma-\lambda}{\delta}\right)^{\beta}\right]; \sigma \geq \lambda$$

2. Description of design model

<u>Part I. Strength:</u> Glass characterization



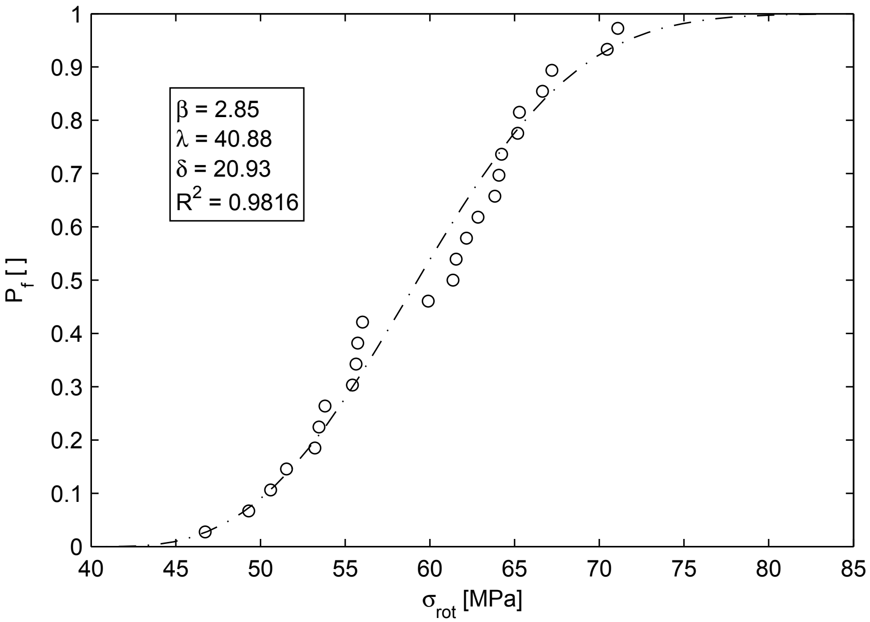
Annealed glass

Tempered glass

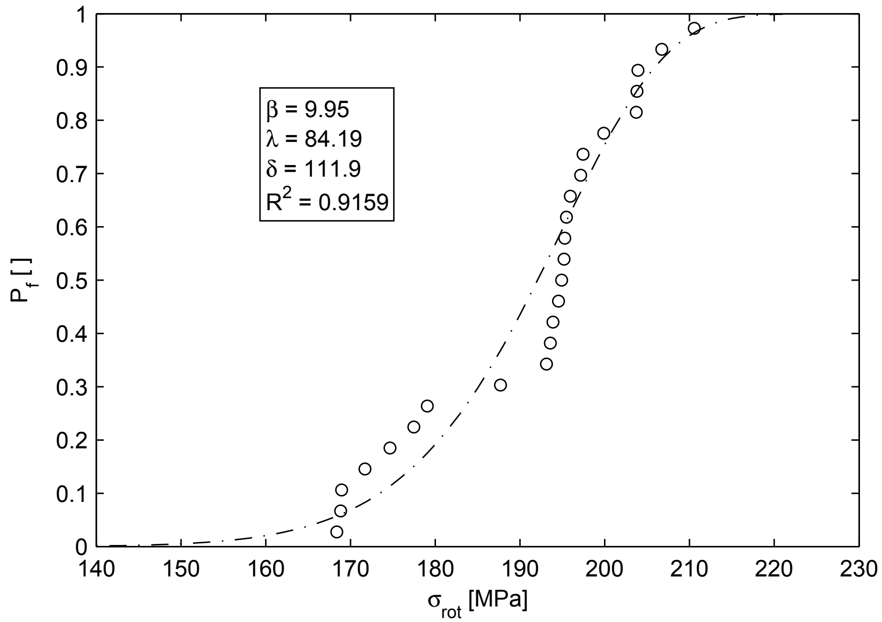
4-P bending test

2. Description of design model

<u>Part I. Strength:</u> Glass characterization



Annealed glass

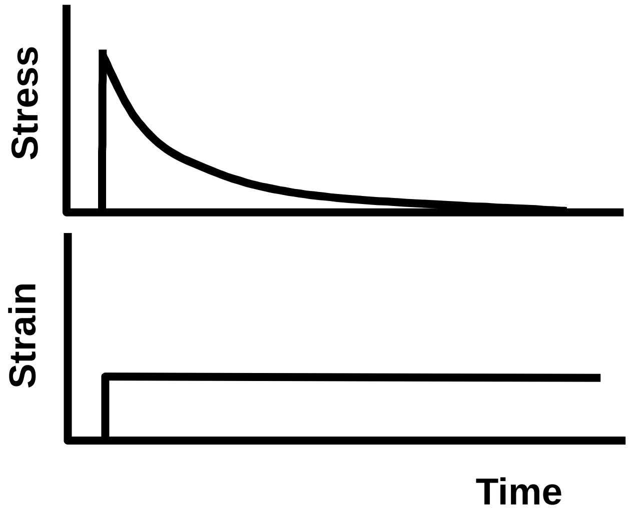


Tempered glass

2. Description of design model

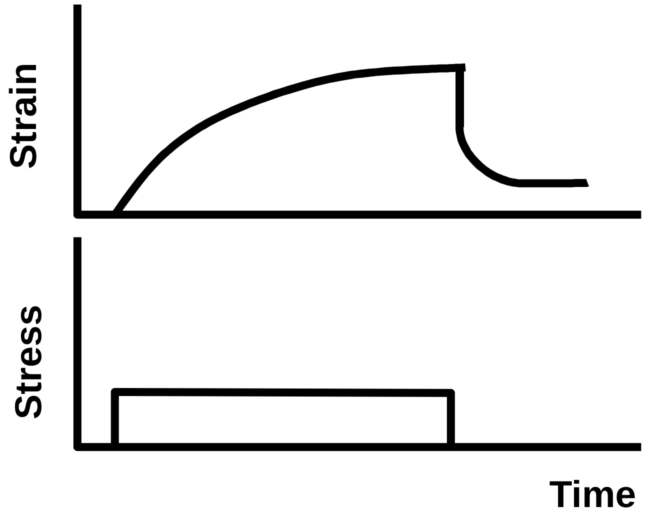
<u>Part I. Strength:</u> PVB viscoelastic characterization

- **Relaxation test**



$$E(t) \quad \frac{\sigma(t)}{{}_{0}}$$

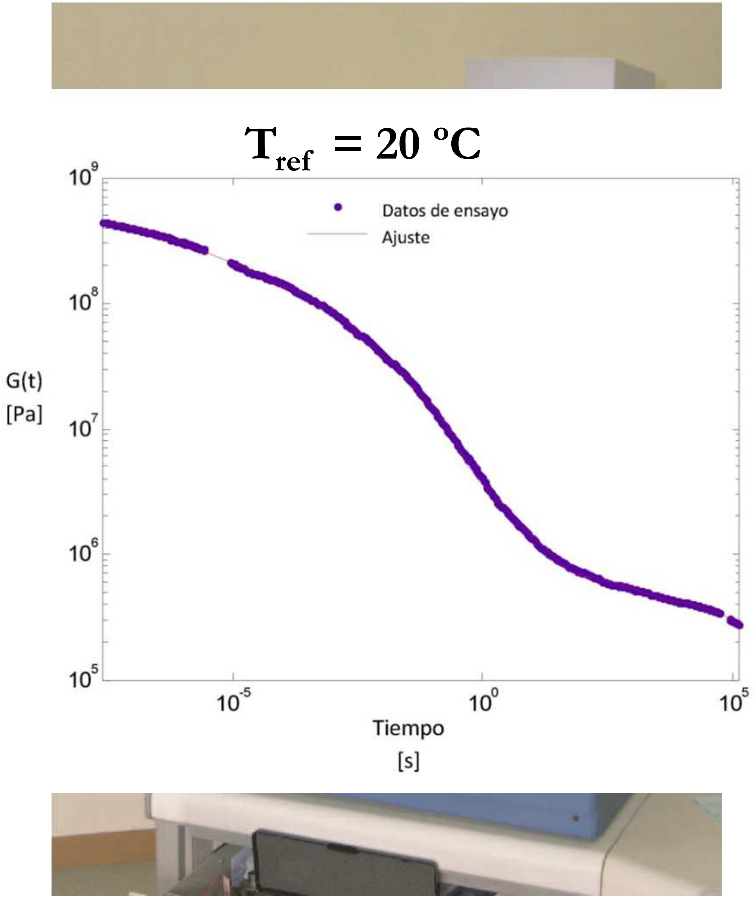
- **Creep test**



$$D(t) \quad \frac{(t)}{\sigma_0}$$

2. Description of design model

<u>Part I. Strength:</u> PVB viscoelastic characterization



DMA RSA3, TA Instruments

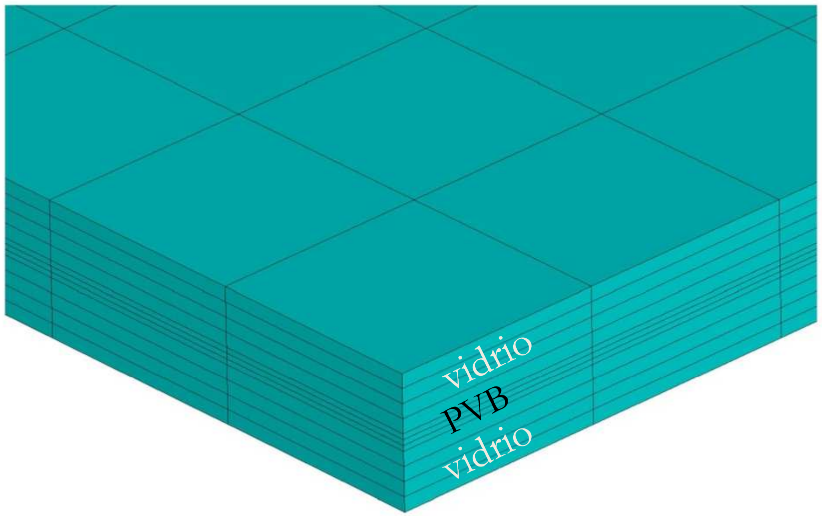
$$G(t) \;=\; \frac{3\,E(t)\;K(t)}{9\,K(t)\;-\;E(t)}$$

$$\mathrm{K(t)} = 2\ \mathrm{GPa}$$

$$G(t) \;=\; G_0\left(1 \;-\; \sum_{i=1}^{n} g_i^* \cdot \left(1 - e^{-\frac{t}{\tau_i}}\right)\right)$$

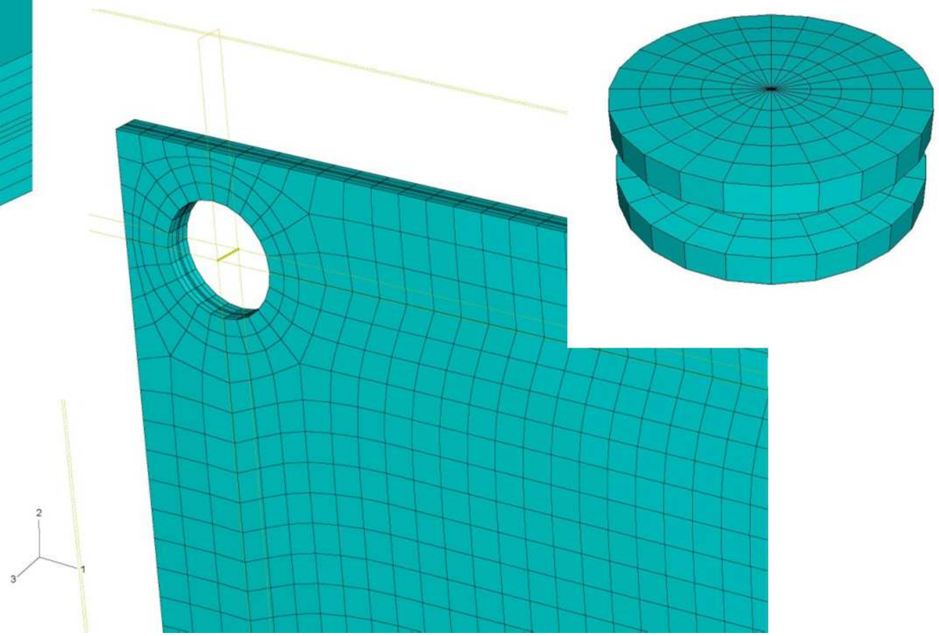
2. Description of design model

<u>Part II. Loading:</u> Finite element analysis (FEA)



Laminated annealed glass

Metallic support



Laminated tempered glass

2. Description of design model

Part II. Loading

Fracture criteria: $$\sigma_{eq} = \frac{1}{2}\left(\sigma_n + \sqrt{\sigma_n^2 + \frac{\tau^2}{(1 - \frac{1}{2}\nu)^2}}\right)$$

Part III. Probability of failure

$$P_f \text{ (plate)} = 1 - \prod_{i=1}^{n}\left[\sum_{k=1}^{p}\frac{1}{p}\,exp\left\{-\frac{A_i}{A_{ref}}\left(\frac{\sigma - \lambda_\sigma}{\delta_\sigma}\right)^{\beta_\sigma}\right\}\right];\ \sigma \geq \lambda_\sigma$$

3. Experimental programme

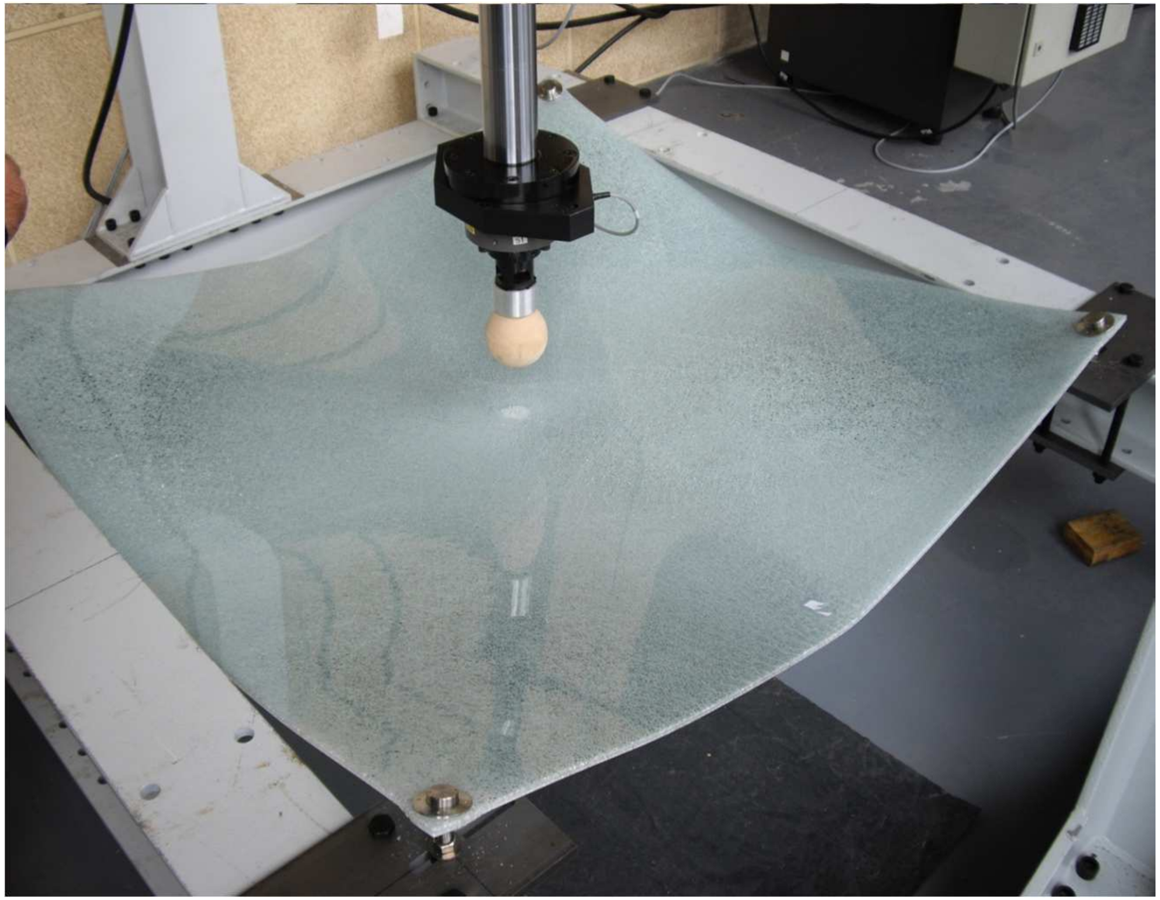
- **Laminated annealed glass**

5 + 5 plates of 1.40 x 1.40 m, e = 6 and 8 mm (v = 3 mm/min)

3. Experimental programme

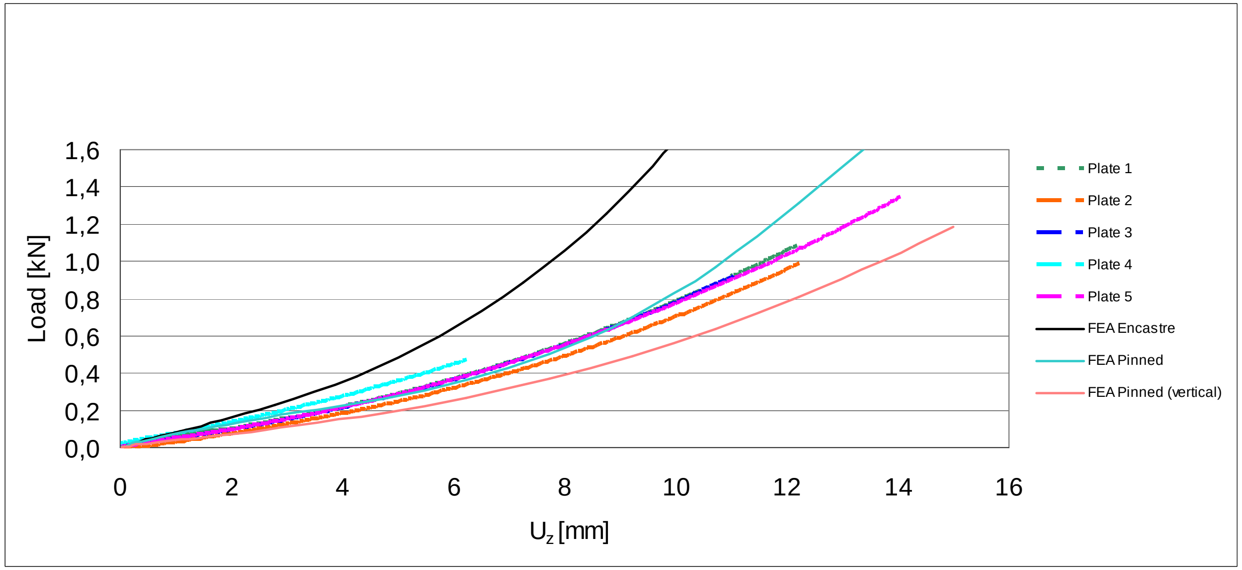
- **Laminated tempered glass**

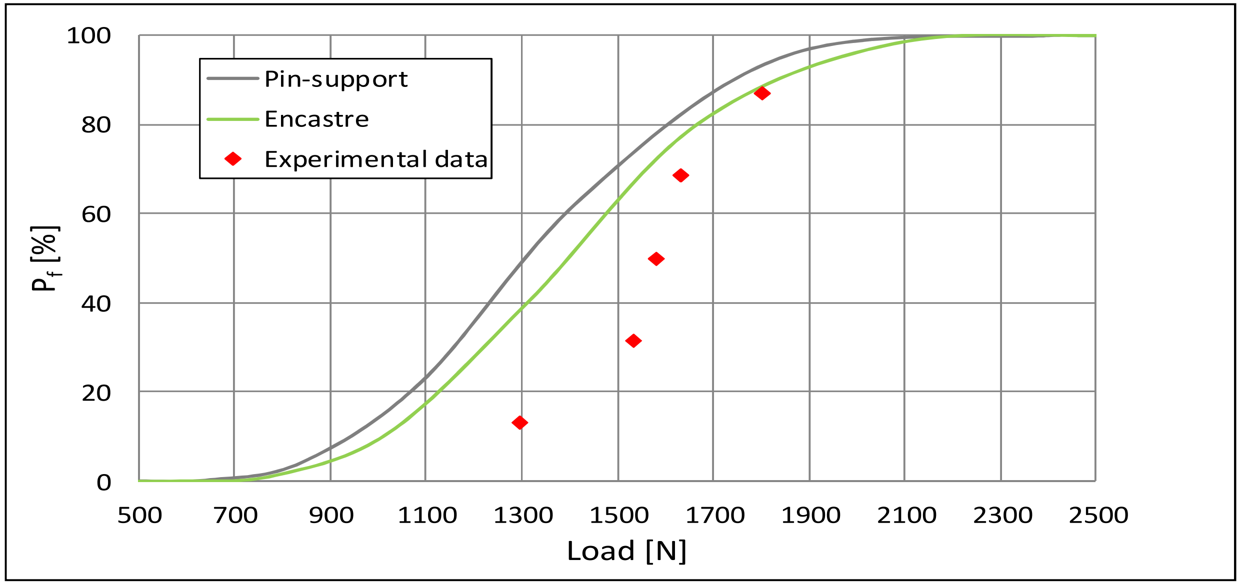
5 plates of 1.40 x 1.40 m, e = 9 mm (v = 10 mm/min)



4. Contrast of results

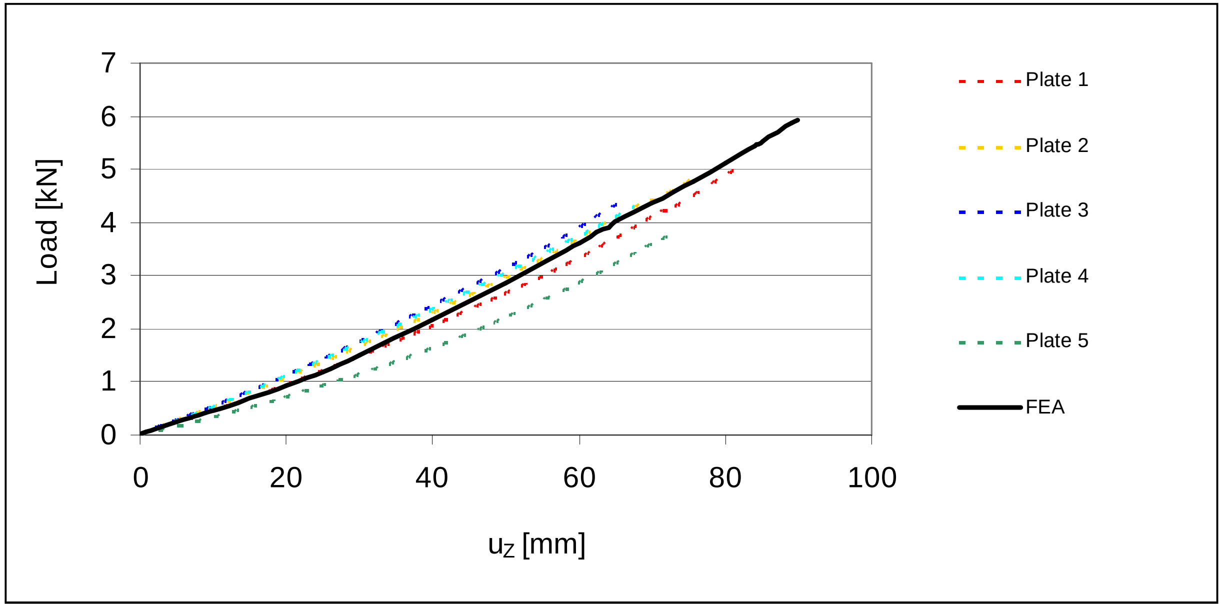
- **Laminated annealed glass plates (6 mm)**

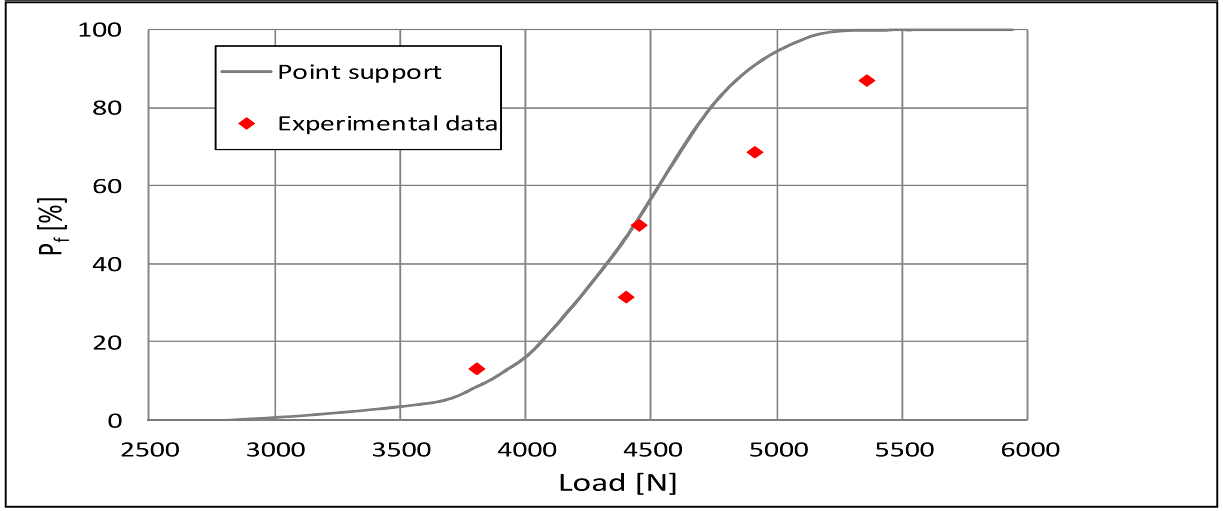




4. Contrast of results

➢ **Laminated tempered glass plates (9 mm)**

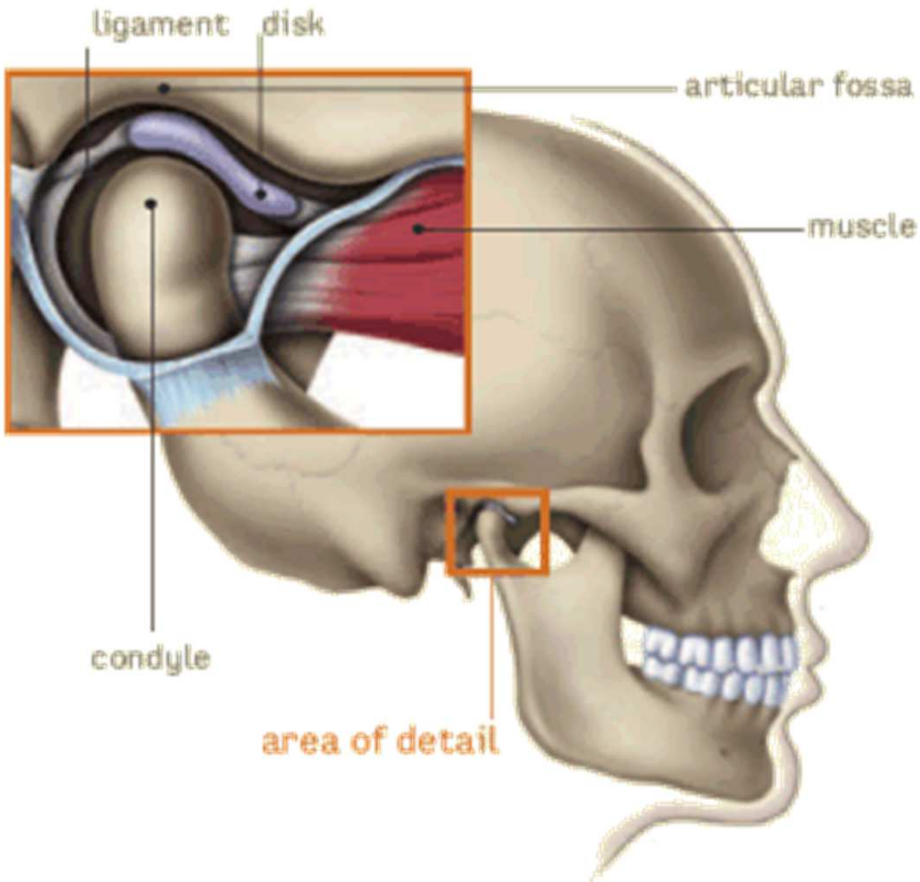


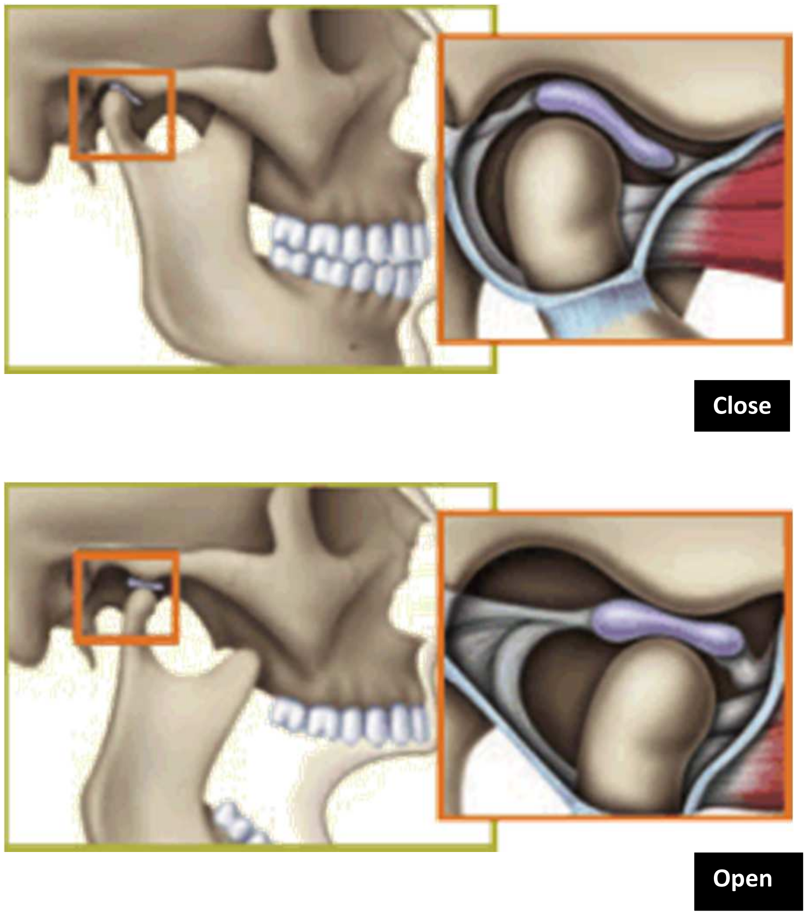


BIOMECHANICAL PROPERTIES OF THE TEMPOROMANDIBULAR JOINT DISC

1. Introduction

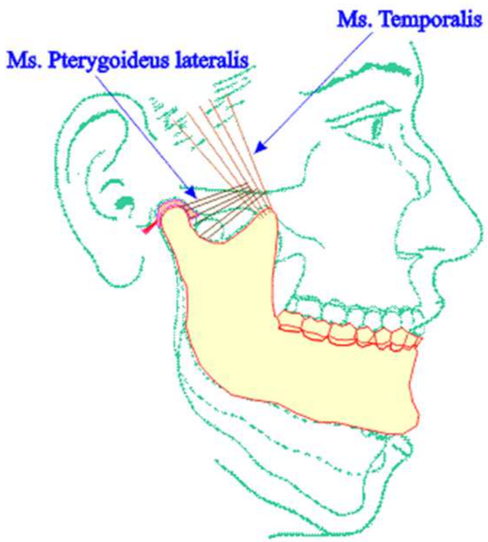
Research Project TMJ, PN 2000-2003 (EPIG,EE-UO & CPS-UZ)
Research Project TMJ, CEI 2011-2012 (EPIG,EE-UO & DO-UT)





1. Introduction

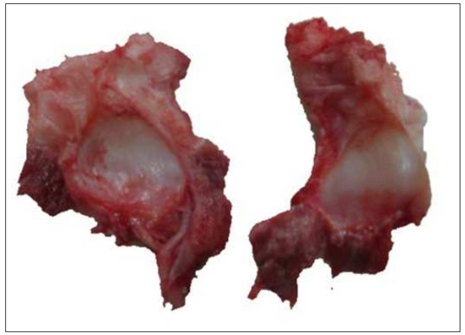
- The aim of this research consists of developing an experimental programme to simulate the behaviour of biological materials (TMJ discs) under real loading in order to know its biomechanical properties and to propose substitutes materials for implants.



Biomechanical machine, W+B

2. TMJ discs characterization

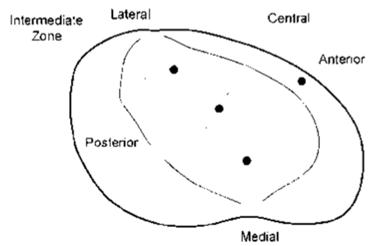
DMA RSA3, TA Instruments

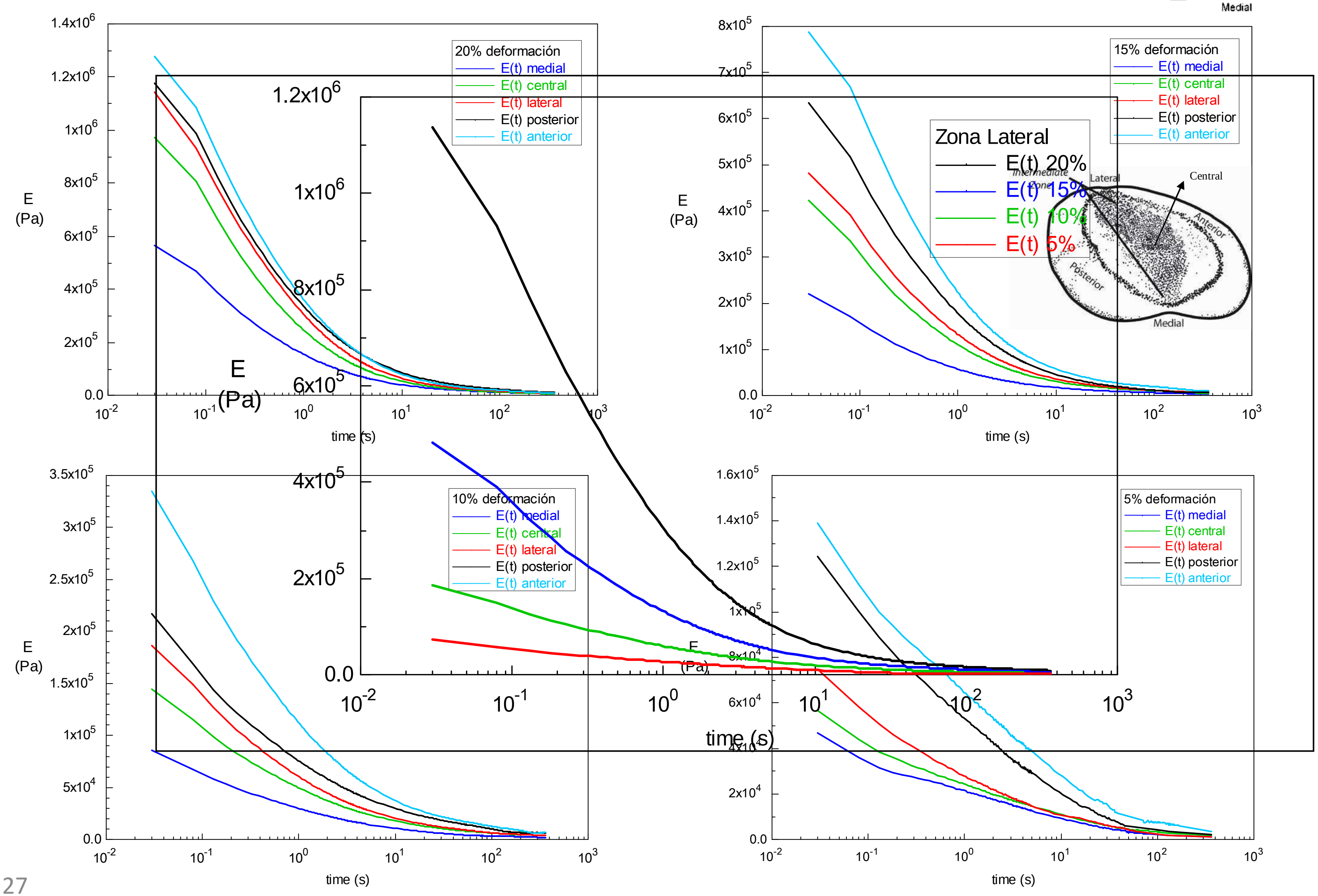


- Relaxation and creep viscoelastic test in compression
- Porcine TMJ discs
- T = 37 ºC and saline solution

3. Experimental programme

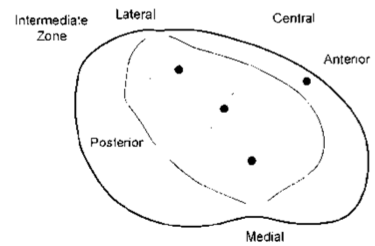
Relaxation tests: = 5, 10, 15 and 20%

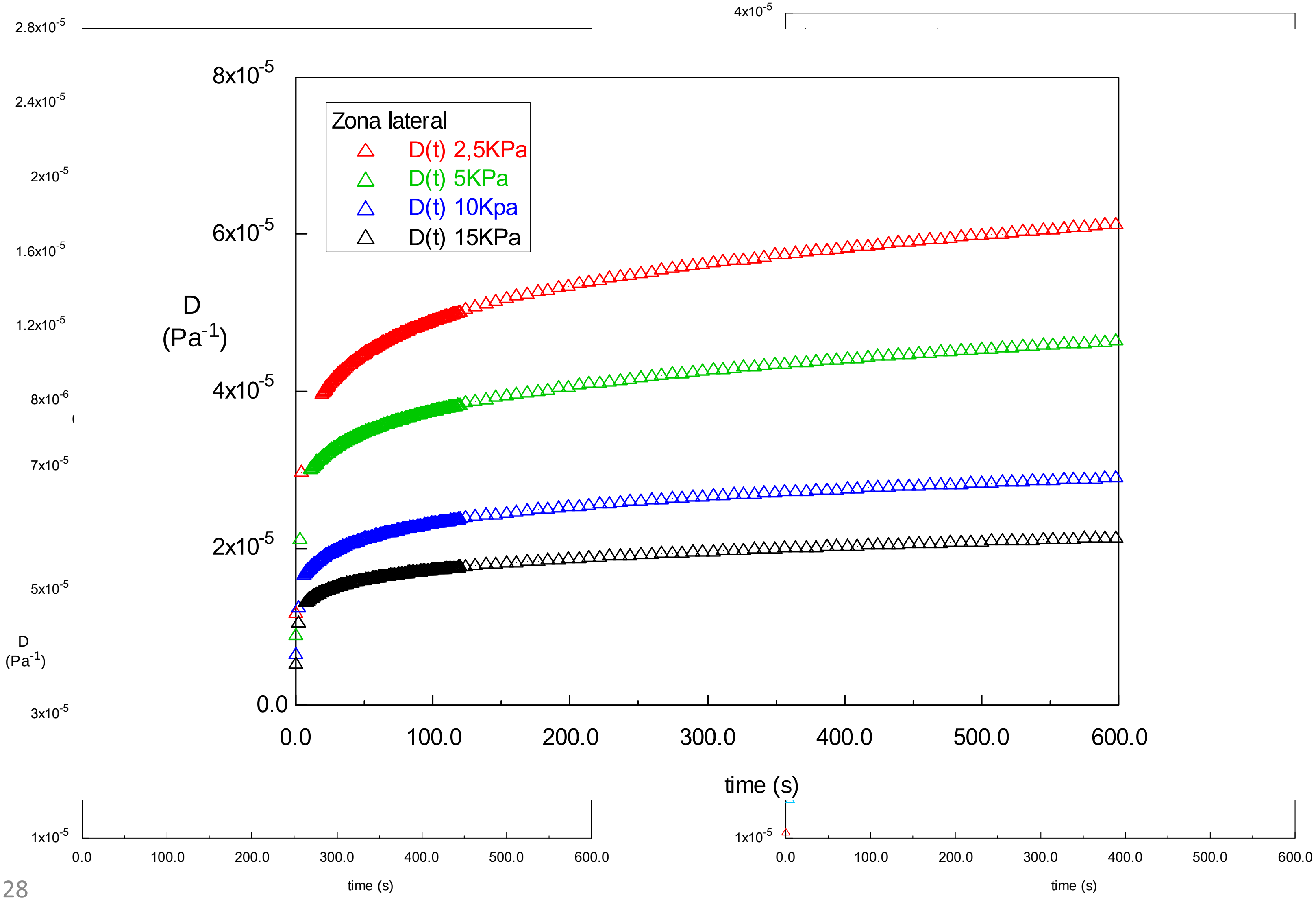




3. Experimental programme

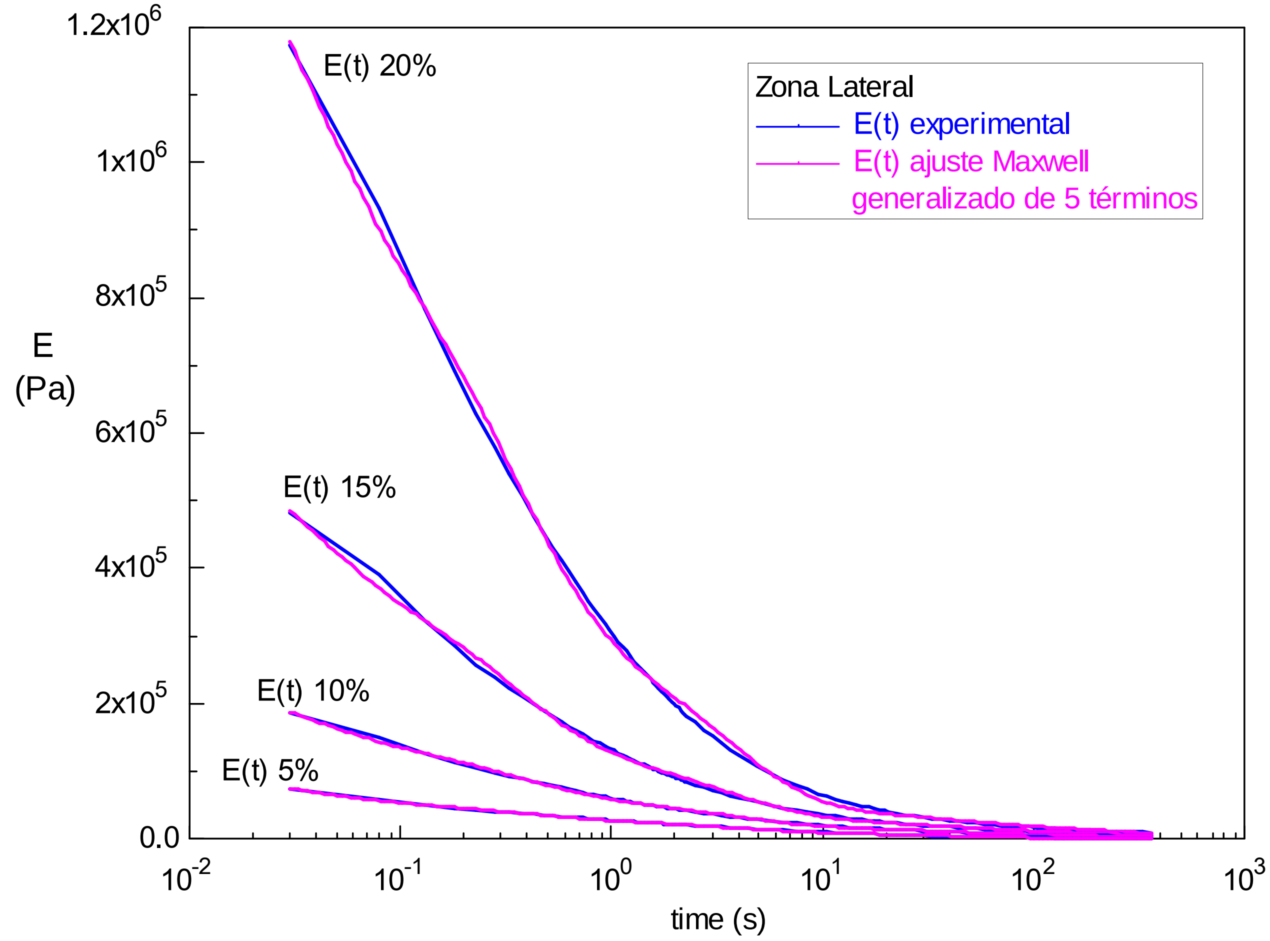
Creep tests: σ = 2.5, 5, 10 and 15 kPa





4. Master curves fitting process

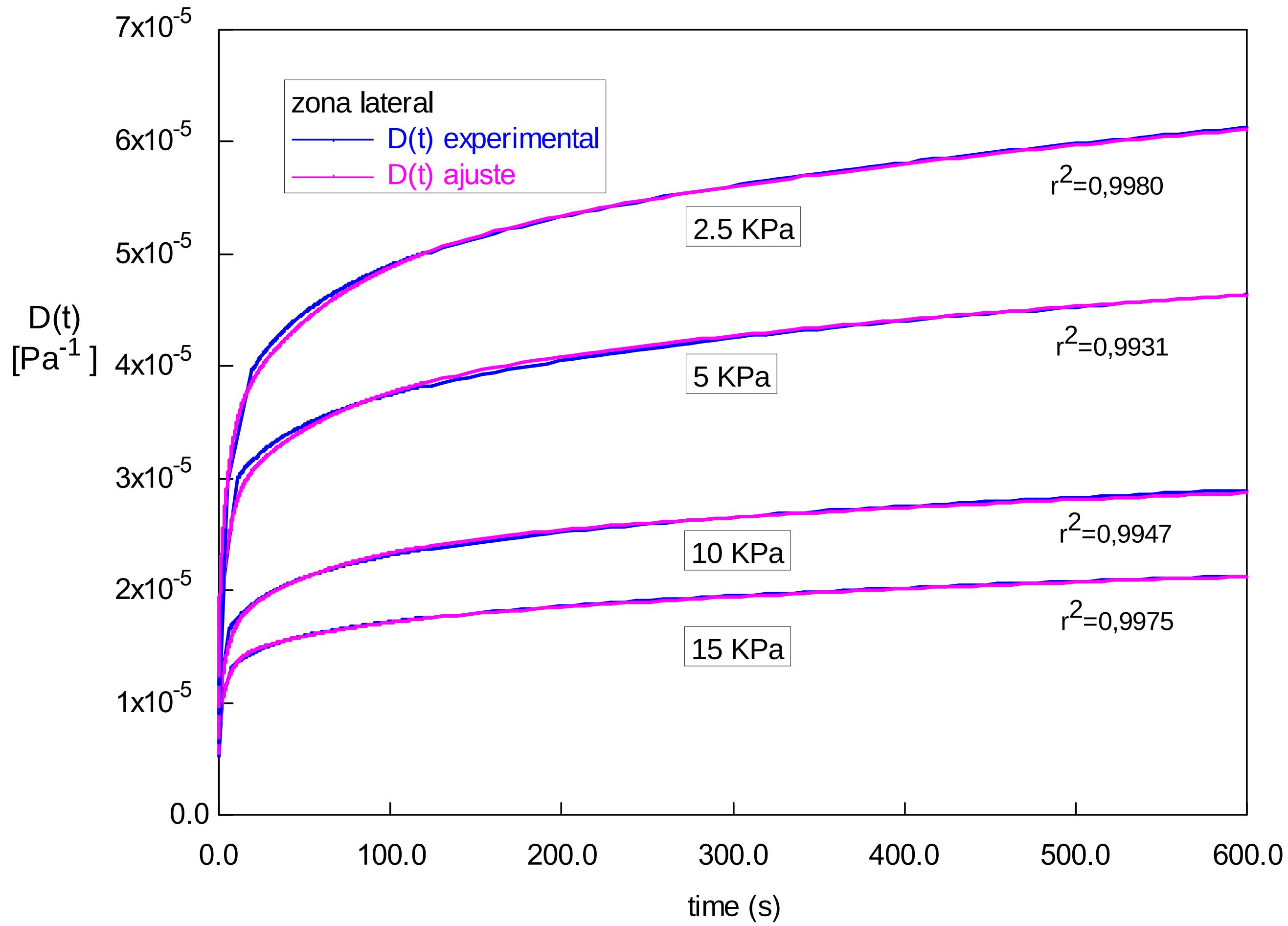
Relaxation Modulus, E(t)



$$E(t, \ _{o}) \qquad \sum_{i \quad 1}^{n} e_{i}(\ _{o}) \exp(\qquad \frac{t}{\ _{i}})$$

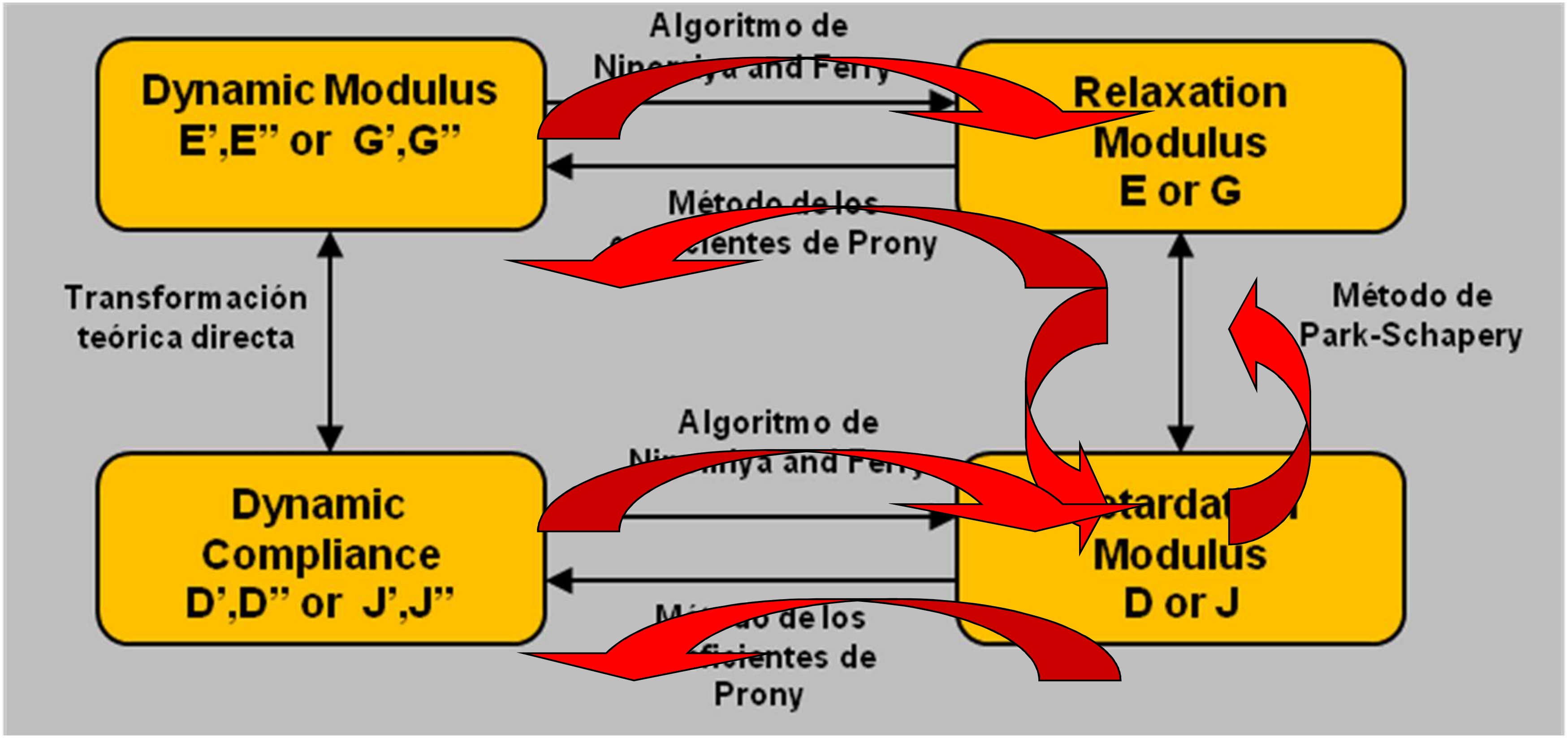
4. Master curves fitting process

Creep Modulus, D(t)



$$D(t,\sigma_o) \quad D_o \quad \sum_{i \quad 1}^{n} d_i(\sigma_o)\left(1 \quad \exp(\quad \frac{t}{i})\right)$$

5. Interconversion methods



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Thank you for your attention !!