

# Challenging Material Characterization

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# The course 'Materials Characterization'

- An elective course in Aerospace MSc program, but other MSc students are also attending this course
- A very inhomogeneous group in terms of knowledge
- Learning goals:
  - Being able to explain the basics of 10 analysis techniques
  - Being able to explain the possibilities and limitations of these techniques
  - Selecting the appropriate analysis technique in a given situation
  - Being able to select complementary techniques and leave out the non-relevant ones

# Materials Characterization Course:

- We treat 10 (surface) analysis techniques
- Seven classic lectures followed by a classical (closed book) exam
- Six **boring** classical lectures
- The challenge for us as teachers is to get and keep the students involved
- No time for meaningful lab visit

# How to make sure they are engaged:

- Challenge them
- Give them money
- Give them competition



# Game rules:

- Groups of students receive a problem
- The students discuss in groups on what information they think is most relevant
- Students decide on which technique to buy
- Teachers hold the results and are the 'bank'
- When they solved their problem, they tell the teachers
  - If correct: time stops, if incorrect they are sent back
- Presentation of the results, where other groups may comment on the outcomes.

# Engineering problem:

Your company specializes in bonding epoxy coatings on aluminum surfaces. Typically the epoxy is cured at 150 °C for 2 hours. However a recent batch of coated aluminum plates showed premature adhesive failure during use.

Find the cause of the problem

# An example:

Your company specializes in bonding epoxy coatings on aluminum surfaces. Typically the epoxy is cured at 150 °C for 2 hours. However a recent batch of coated aluminum plates showed premature adhesive failure during use.

DSC

DMTA

FT-IR

SEM + EDS

Optical microscopy

XPS

UV-VIS

XRD

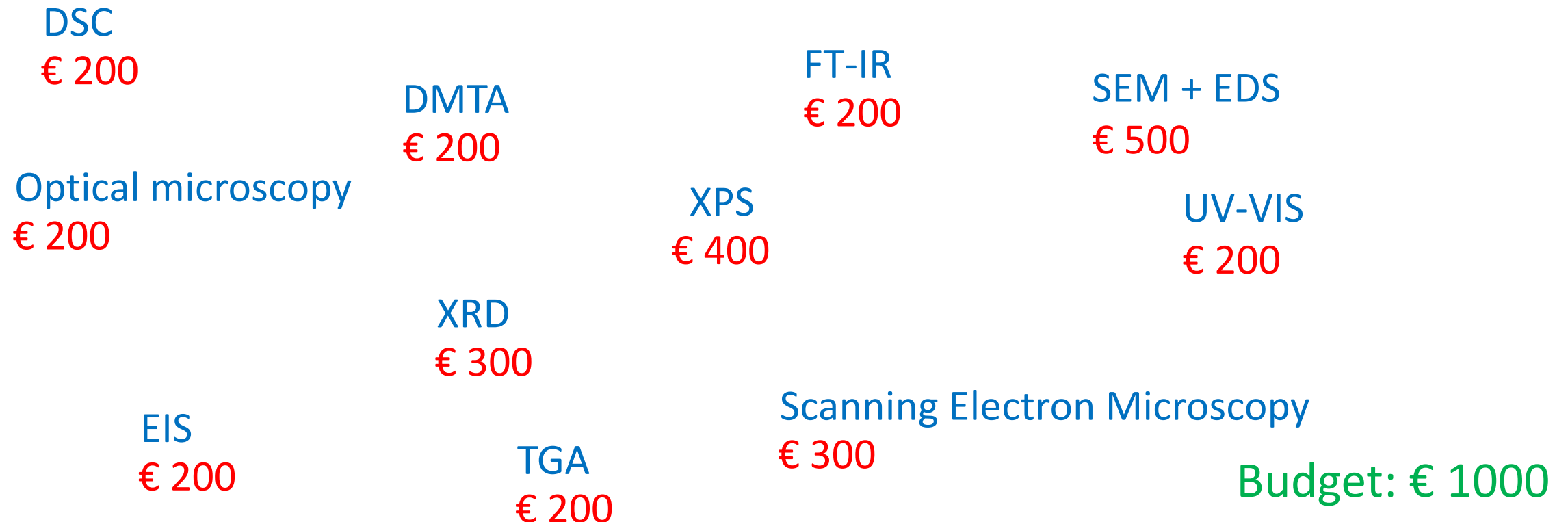
EIS

TGA

Scanning Electron Microscopy

# Even more realistic:

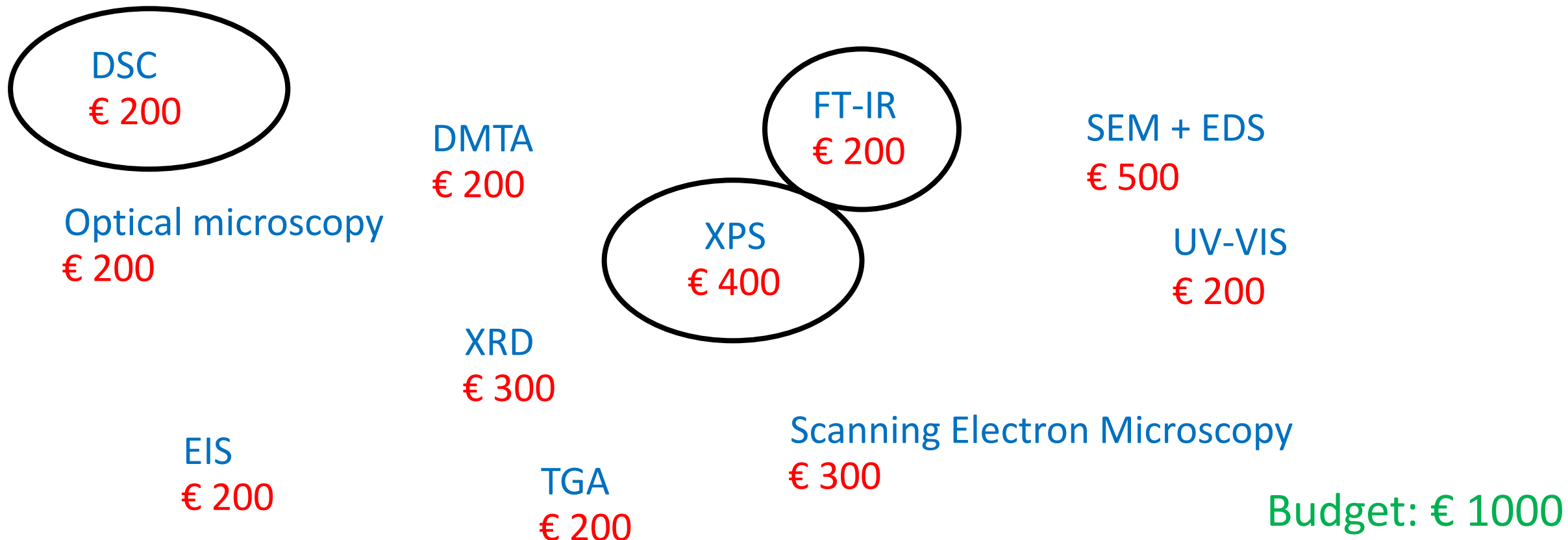
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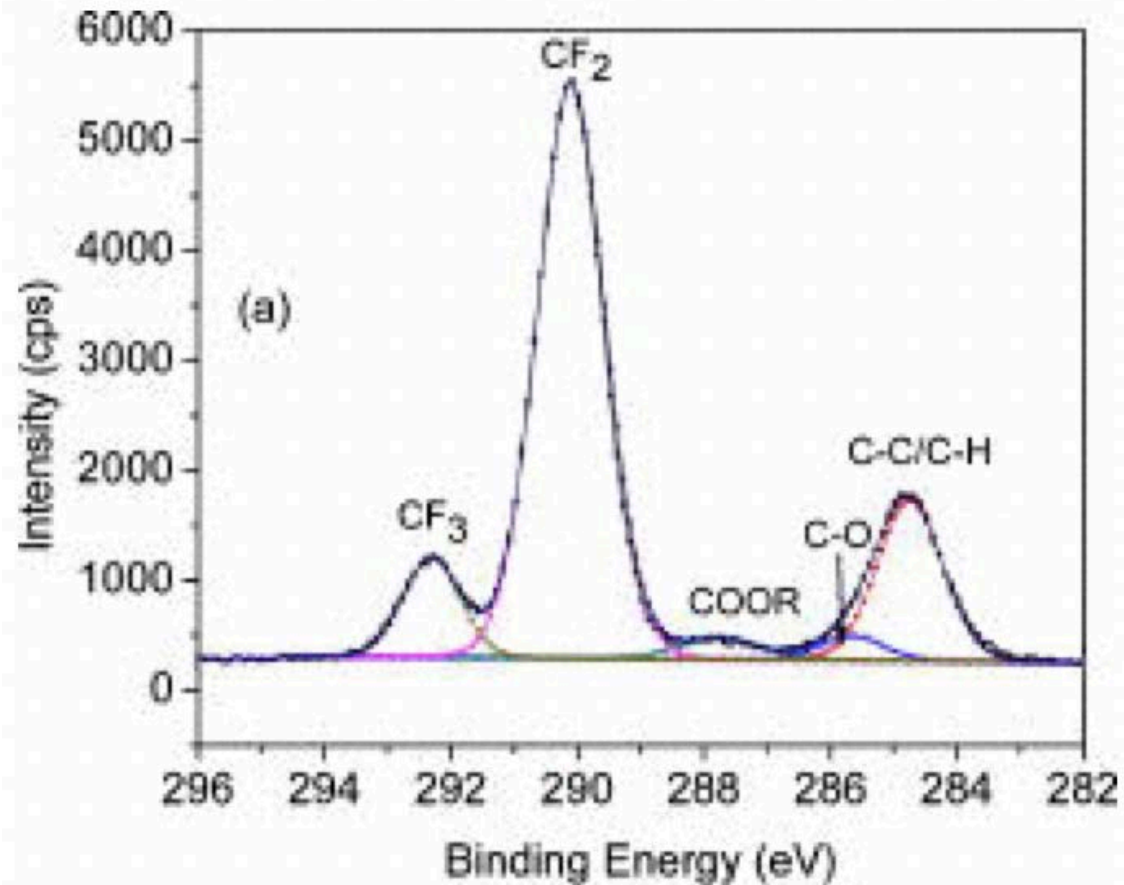
# Possible solution:

Your company specializes in bonding epoxy coatings on aluminum surfaces. Typically the epoxy is cured at 150 °C for 2 hours. However a recent batch of coated aluminum plates showed premature adhesive failure during use.

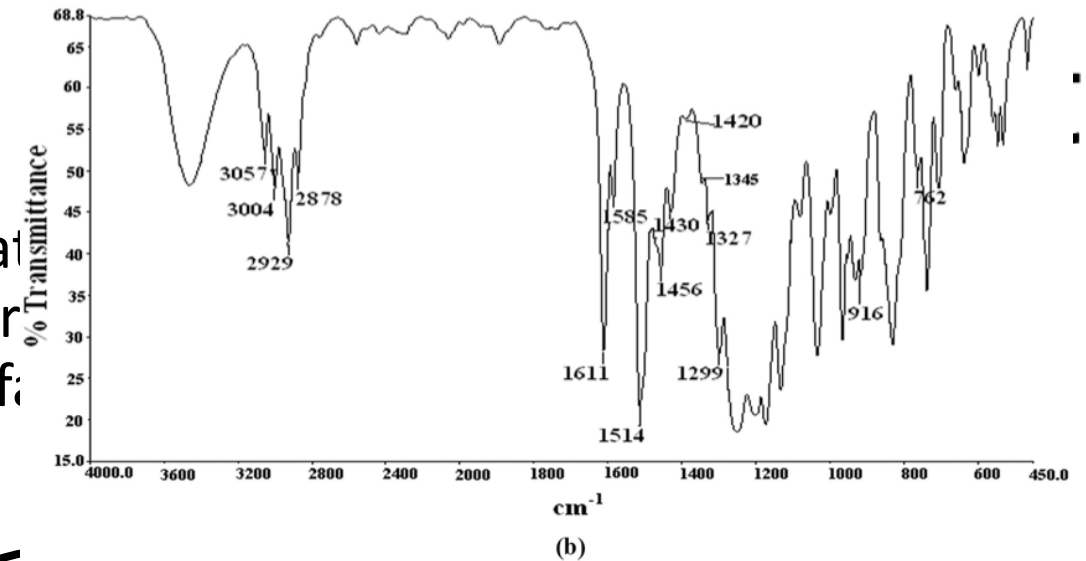


# Possible solution:

Your company specializes in bonding epoxy coating  
Typically the epoxy is cured at 150 °C for 2 hours  
adhesive for



€ 200



FT-IR  
€ 200

XPS  
€ 400

SEM + EDS  
€ 500

UV-VIS  
€ 200

Scanning Electron Microscopy  
€ 300

Budget: € 1000

# Pitfalls for students:



- Not relevant: Blank result
- Too hasty: Not enough complementary results
- Run out of money

DSC  
€ 200

DMTA  
€ 200

FT-IR  
€ 200

SEM + EDS  
€ 500

Optical microscopy  
€ 200

XPS  
€ 400

UV-VIS  
€ 200

XRD  
€ 300

EIS  
€ 200

TGA  
€ 200

Scanning Electron Microscopy  
€ 300

Budget: € 1000

## Remarks:

- Often received as the best lecture in the course
- Students are engaged
- Challenge for the teachers: come up with new real life problems and materials

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€ 200

FT-IR  
€ 200

SEM + EDS  
€ 500

Optical microscopy  
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XPS  
€ 400

UV-VIS  
€ 200

XRD  
€ 300

EIS  
€ 200

TGA  
€ 200

Scanning Electron Microscopy  
€ 300

Budget: € 1000

# Learning Outcome:

- Application of theoretical knowledge
- Learn about complimentary techniques
- Discuss in groups
- Discover real life engineering problems

DSC  
€ 200

DMTA  
€ 200

FT-IR  
€ 200

SEM + EDS  
€ 500

Optical microscopy  
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XPS  
€ 400

UV-VIS  
€ 200

XRD  
€ 300

EIS  
€ 200

TGA  
€ 200

Scanning Electron Microscopy  
€ 300

Budget: € 1000

# Take home message:

- Applicable for a variety of fields:
  - Treat the techniques you have in-house
- Easy to 'produce' the game results:
  - You have the machines standing there anyway

• Competition + Money = engagement

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FT-IR  
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# Challenges

- Come up with realistic problems
- Incorporate the game in the overall assessment

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Dr. Marlies Nijemeisland  
€ 200

DSC  
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