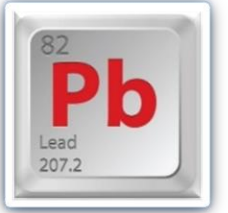


ARGE's Lead (Pb) Reduction Programme

First results of the research projects

Hans Weissenböck

ARGE General Secretary



Content

- ➔ Scope of the two research projects
- ➔ Engaged in the research projects
- ➔ Tests in the first phase of the research projects
- ➔ First findings
- ➔ Project management

Scope of the two research projects



- ➔ **Elimination** or at least reduction of the lead content in **nickel silver and brass keys** (tests on 3 different machining processes)
- ➔ **Reduction** or even better elimination of the lead content in **brass rotors of lock cylinders and padlocks** (tests on broaching of keyways in rotors)

Engaged in the research projects (1/2)



MTI – Manufacturing Technology Institute at the **Technical University in Aachen** (DE)

- 14** manufacturers of keys, lock cylinders and padlocks (see next slide)
- 7** manufacturers of semi-manufacturers (DE, IT, JP)
- 3** tool manufacturers (DE, ES)
- 2** manufacturers of locksmith key cutting machines (ES, IT)
- 2** manufacturers of industrial key making and of broaching machines (DE, IT)

Engaged in the research projects (2/2)



14 Manufacturers of keys, lock cylinders and padlocks

Access 2 (UK)

Altuna Group (ES)

ASSA ABLOY (SE/DE)

BKS (DE)

CES (DE)

CISA/ ALLEGION (IT)

DOM Security (DE)

dormakaba (AT)

EVVA (AT)

Halter (CH)

ISEO (IT)

THIRARD (FR)

WILKA (DE)

WINKHAUS (DE)

**Company names in
amber letters:**

Companies carry out
manufacturing tests at
their factories

Research project 'keys' (1/3)



© MTI – Manufacturing Technology Institute at the Technical University in Aachen

Research project 'keys' (2/3)



Nickel silver materials tested:

Leaded reference:

CuNi12Zn25Pb1 *)

Lead-reduced:

CuNi12Zn25Pb1

Lead-free:

CuNi12Zn25Pb1

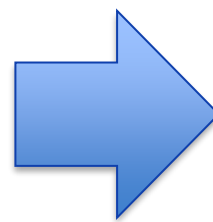
CuNi13Zn24S0,1

CuNi13Zn25Pb1

CuNi7Zn32Pb1

SUNDWIGER
Messingwerk

wieland



Materials selected for the next phase of testing:

- **1** lead-reduced material (0.45% lead)
- **1** lead-free material (0.09% lead)

*) Leaded reference material: 0.93% lead

Research project 'keys' (3/3)



Brass materials tested:

Leaded reference:

CuZn39Pb2 *)

Lead-reduced:

CuZn39Pb1

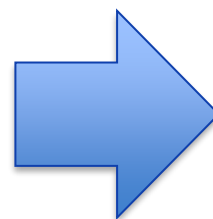
CuZn39Pb0,5

Lead-free:

CuZn40

CuZn42

CuZn42



Materials selected for the next phase of testing:

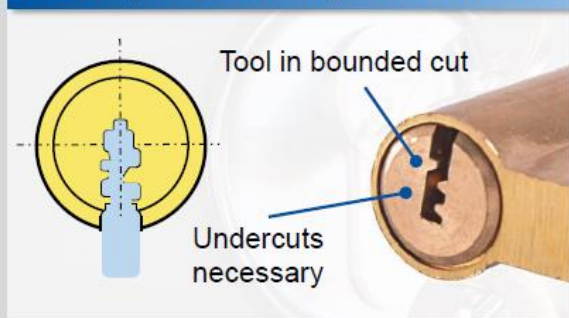
- **1** lead-reduced material (0.5% lead)
- **1** lead-free material (0.0033% lead)

*) Leaded reference material: 2.3% lead

Research project 'lock cylinders' (1/3)



Broaching Process of Key Profile Channels



Poor accessibility for analysing the chip formation processes



Influence of the machining process by many non-quantifiable influencing variables

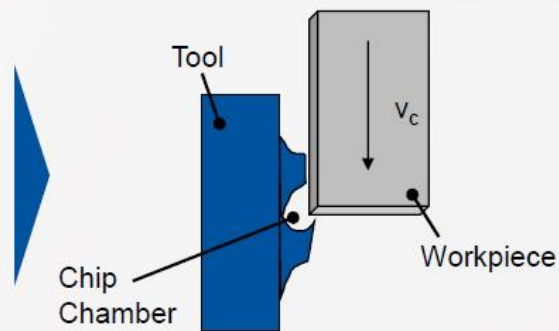
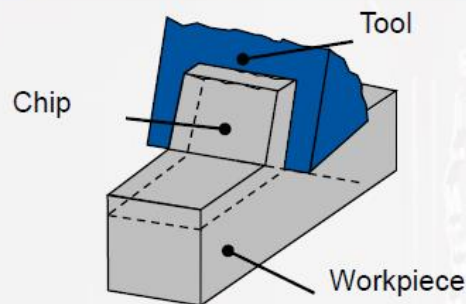


An abstraction of the process to analogy process is necessary

Complex Tool Geometries



Analogy Process



Result of the analogy process conditions:

- Camera accessibility for chip formation evaluation
- Visual assessment of the chip flow and chip breaking behaviour in the chip chamber
- Evaluation of the cutting force under defined cutting conditions (combination of tool geometry and depth of cut)

Research project 'lock cylinders' (2/3)



FORST RASX 8x2200x600 M / CNC

Experimental Setup

High-Speed-Camera

Workpiece

Tool

Force Measurement Platform

Measurement Devices

HighSpeed-Camera:

- Phantom v7.3

Force Measurement Platform:

- Kistler Type 9257

Variation Variables

- Rake Angle γ
- Clearance Angle α
- Depth of Cut h

Evaluation Criteria

- Cutting Force Components
- Chip Breaking Behaviour
- Chip Form
- Chip Evacuation
- Burr Formation

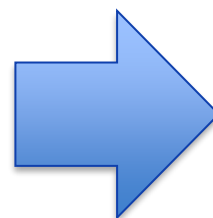


Research project 'lock cylinders' (3/3)



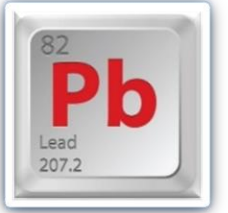
Workpiece Materials	
Leaded Reference	
wieland	CuZn39Pb3 *)
Lead-Reduced	
	CuZn40Pb1 CuZn42Pb0,2 CuZn39Pb1
Aurubis	CuZn39Pb0,5
Lead-Free	
DIEHL	CuZn37Mn3Al2Si CuZn41Mg CuZn21Si3P
wieland	CuZn21Si3P (SW1) CuZn21Si3P (SW4) CuZn40SiP CuZn42
	CuZn21Si3P CuZn42
Aurubis	CuZn42
	Globrass

Materials selected for the next phase of testing:



- **1** lead-reduced material (1.2% lead)
- **3** lead-free materials (0.05% – 0.06% lead)

*) Leaded reference material: 3.3% lead



First findings (applicable for both, keys and lock cylinders)

- ➔ **Best lead-reduced materials** (lead reduction between 52% and 78%):
 - ⇒ Surprisingly good machinability, better than expected
- ➔ **Best lead-free materials** (lead content below 0.1%):
 - ⇒ Worthwhile to be tested further; outcome still open



Project management:

- ➔ **The project is proceeding according to schedule;** planned project end in December 2025 / January 2026
- ➔ **By end of 2024, external project costs will amount to approx. € 155k,** which is in line with the plan (total external project costs approx. € 470k)

Thank you!

Any questions?