IMPRESSION MATERIALS

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PROBLEM ANALYSIS
What are tolerable limits for “error” in indirect procedures?

- Impressions = +/- 0
- Casts, Dies = +/- 0
- Waxing = +/- 0
- Investing = +/- 1.5%
- Casting = +/- 1.5%
- Finishing, Polishing = +/- 0
- Cementation = +/- 0

Typical clinical error = >100 µm/side

Prepped Tooth Width:
8 mm (=8,000 µm)
8,000 µm x 0.5% = 40 µm = 20 µm/side

DIGITAL IMPRESSIONS
How much longer will we use regular impression materials?

CONVENTIONAL	DIGITAL
- Impressions	+/- 0	- Digital Impression
- Casts, Dies	+/- 0	- Digital Replica
- Waxing	+/- 0	- Oversized Digital Design
- Investing	+ 1.5%	- (Eliminated)
- Casting	- 1.5%	- Digital Fabrication
- Finishing, Polishing	+/- 0	- Finishing, Polishing
- Cementation	+/- 0	- Cementation

CLASSIFICATION SYSTEM
Based on properties of set materials.

- React.: Set:
  - Rigid: Irrev (Chem)
  - Flexible: Rev (Phys)

- Water-Based Gels:
  - Alginate (Irreversible Hydrocolloid) Flexible Irrev (Chem)
  - Agar-Agar (Reversible Hydrocolloid) Flexible Rev (Phys)

- Elastomers (and their HYBRIDS):
  - Polysulfide (Rubber Base, Thiokol) Flexible Irrev (Chem)
  - Silicone (Conventional, Condensation) Flexible Irrev (Chem)
  - Polyether Flexible Irrev (Chem)
  - Polyvinyl Siloxane (Addition Silicone) Flexible Irrev (Chem)

KEY PROPERTIES
3 major concerns.

- Accuracy = ability to replicate the intraoral surface details.
- Dimensional Stability = ability to retain its absolute dimensional size over time.
- Tear Resistance = ability to resist tearing in thin sections (such as through the feather-edged material within the gingival sulcus.

HOW DO YOU RUN THE TESTS?
Tests for accuracy, dimensional stability, and tear resistance?

- Accuracy
- Dimensional Stability
- Tear Resistance

http://www.youtube.com/watch?v=g7FDEMJSjmQ
1. Flexible Matrix (Continuous Phase):
   a. Multifunctional Pre-Polymer or Polymer
   b. Crosslinking Agent
   c. Curing Agent (Catalyst or Initiator)
   d. Modifiers (Accelerators, Retarders, Plasticizers, Flavoring Agents, Colorants)
   e. Wetting and flow aids.

2. Filler or Extender (Dispersed Phase):

   - Polymer (high shrinkage)
   - Filled Polymer (low shrinkage)

GENERAL FORMULATION
Elastic impression materials.

SHRINKAGE MANAGEMENT
Elastomeric impressions.

- Use 2-step techniques:
  (a) Light-Heavy Body, OR
  (b) Wash-Putty

- Load tray with heavy-bodied IM
- Cover prep with light-bodied IM from syringe

During setting shrinkage, distortion of impression is toward tray.

Dies tend to be oversize and so the casting is oversize.

MIXING AND DELIVERY
Elastomeric impressions.

- Mixing Options:
  1. 2 Pastes on Mixing Pad
  2. 2 Pastes in Mixing Gun
  3. 2 Pastes in Mixing Machine

DISTORTION
Distortion during tray removal.

- Strain rate sensitive elastomers!

- VERY FAST (SNAP)
- Slow removal

IMPRESSION MATERIALS
Distortion related to setting reaction.

- VPS
- Pe
- PS, Silicone

REACTION CONVERSION (%) vs log TIME (minutes)

POLYSULFIDE RUBBER
Chemistry and setting reaction.

CONTINUOUS PHASE:
Polymer
- Mercaptan Functional Polysulfide
- Sulfur and/or Lead Peroxide
- PbO2 or Copper Hydroxides (Type I)
- Zinc Peroxide or Organic Hydroperoxide (Type II)

DISPERSED PHASE:
Fillers
- TiO2 or Zinc Sulfate or Lithopone or Calcium Sulfate Dihydrate

SETTING REACTION:
Stepwise (relatively slow), Exothermic, Affected by temperature
POLYSULFIDE RUBBER
Manipulation and technique considerations.

a. Two-step technique recommended: Reduces air entrapment and surface tension effects.
b. Set impression should be removed quickly — do not rock tray.
c. No syneresis or imbibition, but distortion due to continued reaction.
d. Ideally need uniform thickness and at least 2 mm thick for accuracy.
e. (1) Adhesive must be thin
(2) Adhesive must be dry
f. Paste-Paste Mixing Recommendations:
   (1) Dispense pastes at the top of the mixing pad
   (2) Mix pastes with tip of spatula only for 5 seconds
   (3) Transfer mass to fresh surface at center of mixing pad
   (4) Wipe spatula off with paper towel; Strop mass for 15 s to constant color
   (5) Load syringe or tray
   (6) Use pad excess to monitor setting time
g. Pouring of models:
   (1) Wait 20-30 minutes before pour for stress relaxation to occur
   (2) RB is non-reactive with model and die materials
   (3) Be careful of glove powder contamination of impression
   (4) RB can be electroplated

SILICONE RUBBER
Chemistry and setting reaction.

CONTINUOUS PHASE:
Polymer = Polymethyl Siloxane
Crosslinking Agent = Organo Tin Compounds (e.g., tin octoate)
Catalysts = Organotin Compounds (but not dibutyl tin dilaurate)
Modifiers = Colorants, Flavorants

DISPERSED PHASE:
Fillers = Silica

SETTING REACTION:
Stepwise (relatively slow), Exothermic, Affected by temperature
H2O by-products

POLYETHER RUBBER
Chemistry and setting reactions.

CONTINUOUS PHASE:
Polymer = Amin-terminated Polyether
Crosslinking Agent = Aromatic Sulfonate
Catalysts =
Modifiers = Colorants, Glycol Plasticizers, Flavorants

DISPERSED PHASE:
Fillers = Silica

SETTING REACTION:
Stepwise (relatively slow), Exothermic, Affected by temperature

POLYVINYL SILOXANE
Chemistry and setting reactions.

CONTINUOUS PHASE:
Polymer = Double-bond-functional Silicone Polymer
Crosslinking Agent = Chlорoplatinic Acid
Catalysts =
Modifiers = Colorants, Flavorants, Plasticiizers

DISPERSED PHASE:
Fillers = Silica

SETTING REACTION:
Chain (very fast), Exothermic, Affected by temperature
Hydrogen gas released by decomposition of crosslinking agent.
POLYVINYL SILICONE
Manipulation and technique considerations.

- BEST impression material for dimensional stability:
  Pouring should be delayed at least 4 hours for H2 out-gassing.
  Pouring can be delayed up to 7-to-10 days (or indefinitely).
- Stiffness makes removal difficult.
- Most material dispensed using auto-mixing gun and mixing tips

COMMERCIAL PRODUCTS
1980-1995
Predominantly POLYMER and SILICONE elastomers before 1995.

COMMERCIAL PRODUCTS
1996-2004
Predominantly POLYETHER and PVS elastomers after 1996.

COMPARISON OF IMPRESSION MATERIALS

1. Accuracy (Reproduction of Detail):
   a. Wetting of Tissues: ALG < SIL, PS < PE <= RHC, PVS
   b. Wetting by Dental Stone: SIL, PVS < PS < PE <= ALG, RHC

2. Dimensional Stability: ALG <= RHC < PS, SIL < PE, PVS
   (Resistance to Distortion):
   a. Polymerization Shrinkage
   b. Thermal Shrinkage
   c. Loss of Components
   d. Stress Relaxation

3. Tear Resistance (Elasticity): ALG, RHC, PE < PVS, SIL < PS
   a. Elastic Deformation
   b. Strain Rate Sensitivity

DIMENSIONAL STABILITY
Comparison of products.

POOR > Good

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<th>Manufacturer</th>
<th>Polyurethane</th>
<th>Cure</th>
<th>Silicon</th>
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QUICK REVIEW
Review of uniaxial analysis, normalization, and stress-strain.

- Which indirect procedural step involves the greatest shrinkage?
  COOLING OF A CAST ALLOY
- What are the 3 major categories of all impression materials?
  RIGID; WATER-BASED; ELASTOMERS
- What are the 4 types of ELASTOMERIC impression materials?
  POLYURETHANE, SILICONE, POLYMER, VINYL POLYSILICONE
- What are the 3 most important PROPERTIES?
  ACCURACY, DIMENSIONAL STABILITY, TEAR RESISTANCE
- What are the major categories of COMPONENTS?
  PRE-POLYMER, CROSSLINKING AGENT, CURING AGENT, MODIFIER, WETTING/FLOW AIDS.
- During shrinkage, in what direction does distortion occur?
  TOWARD THE TRAY.
QUICK REVIEW
Review of uniaxial analysis, normalization, and stress-strain.

• What TERM describes materials that flow better under stress? PSEUDOPLASTIC
• What TERM describes effects of distortion time on properties? STRAIN RATE SENSITIVITY
• What type of setting reaction does POLYETHER undergo? STEPWISE POLYMERIZATION
• What type of setting reaction does PVS undergo? CHAIN REACTION POLYMERIZATION
• Which impression material has the best OVERALL properties? PVS.
• Which impression material is the most ACCURATE? POLYETHER.