INSTRON Universal Strength Tester: Standard Operating Procedure

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Description

This device is a model # 5567 electromechanical or universal testing machine. This single frame has the capability to function in various modes including tensile, compression, shear, flexure and bend tests. The capacity for this system ranges from low-load forces of 0.5 kN (112 lbf) up to high-capacity 600 kN (135,000 lbf). The entire device is operated and controlled via a commercial software (*Bluehill*) installed on an external computer. In this research group, this device is currently used for compression tests alone and the highest load used in experiments is 40kN. Two sets of die-punch assemblies are utilized, with diameters of 0.25" and 0.5" respectively.

Preparation for Experiment: Cleaning

1) Ensure that the work area is clear of dust, debris, material samples, and any lab components not directly used for the experiment.
2) Get the desired die and punch assembly, clean paper towels and cleaning solvents.
3) Tear the paper towel into tiny pieces-these will be used to clean the die
    a. Set-up the assembly with the die on top of the base plate. Add the smallest punch into the die opening.
    b. Now, roll the small pieces of paper towel in between the palms and add to the die opening. Continue adding until the cavity is filled up. Add around 1mL of solvent on top of the paper pile inside the cavity.
    c. Now, position the medium punch and large punch on top of this paper filled cavity and position the other base plate on top.
    d. Take this entire assembly and position it on the manually operated hydraulic press (This is present across the INSTRON device, right next to the fume hood). Ensure that the die-punch assembly is positioned in the center of the press surface.
    e. Use the lever on this press to manually compress the die component. Stop once a maximum is reached and it cannot be pushed anymore.
    f. Unwind lever on the manual press to release it.
    g. Remove the base plate on the top and bottom and the large punch. Position the die (with the paper and small punch inside it) on top of the separate holder (provided by the die manufacturer).
    h. Again, use lever to apply pressure so the smaller punch as well as the "paper' pellet exits from the die.
    i. This procedure cleans the die as well as the punches. The paper die can typically be discarded in regular trash. If a lot of powder is found on this paper pellet, consider special precautions in discarding the same.

Performing the Experiment

1) Before setting up the die-punch assembly, choose the appropriate program from the *bluehill* software. Prepare the program such that the "Start" button appears on the monitor (home page).
2) Firstly, take the die and blow compressed air through the cavity. Repeat the procedure via both ends of the cavity.

3) In a similar manner, the lubricant (WD-40) is sprayed from both ends of the cylindrical cavity. Allow a couple of minutes for the spray to dry.
4) Meanwhile, measure the desired mass of powder in a separate paper or cup.
5) Once the die is ready, set up the assembly. Same order as described previously-the die on top of the base plate, and the small punch inserted into the die cavity. Next, add the measured powder mass into the die.
   Caution: While adding powder, be careful to drop it right in the center to prevent sticking of powder on the walls as much as possible.
6) Add the medium punch on top of the powder layer and use a caliper to measure the height/distance from the top of the medium punch to the top surface of the die. This can be utilized to calculate the pellet initial height (knowing the dimensions of the other components of the assembly).
7) After this measurement, add the large punch and second base-plate on top.
8) Open the door of the testing device. Carefully position the assembly inside the testing rig. If needed, use the black switch on the bottom right of the device to move the top shaft to make space for the assembly.
9) Once positioned, use the tunable button to slowly move the top shaft again such that it barely touches the top of the die-punch assembly. Close the door of the device slowly.
   Caution: Make certain this step is executed very slowly. A fast rate can create unwanted compression in the system and skew test results.
10) Now, if any resultant force is observed in the numbers on the software, tare them to zero and press start.
11) Once the test finished per the chosen program, a message "*Test completed. Preparing to stop. Safe to remove sample*" will appear. At this point, slowly open the door and remove the assembly carefully from the device.
12) Repeat steps 3d-h outlined previously to extract the pellet from the die.
13) Once the pellet has been obtained, measure the thickness using the caliper if desired and then store it carefully in a labeled vial or zip-lock bag.

General Safety Precautions

Personnel Safety

1) Ensure personnel protection equipments (PPE) are worn at all times. This includes gloves, laboratory coat and safety glasses.
2) While extracting the pellet using the manual hydraulic press at the end of the test, make sure appropriate precautions are taken depending on the sensitivity of the materials. Exposure to excessive friction is not advisable for such materials.
3) When working with sensitive materials, consider using a smaller die (to minimize the mass of sample utilized in the experiment).

Equipment Safety

1) During cleaning and the actual experiment, always make sure the die-punch assembly is position in the center of the compression zone. Positioning it away from the middle may cause breaking of the punch head or affect experimental repeatability.