SUMMARY

The present disclosure addresses the above problems by providing methods and materials capable of rapid low tolerance fabrication of recessed features in a substrate such as, e.g., a cover glass. Advantageously, methods according to the present disclosure are also effective to remove material and/or polish the resulting surface in a simple process at a higher rate than slurry polishing methods, with less mess and waste, and with good reproducibility. Surface polishing generally improves the strength of the glass after forming the recess.

In one aspect, the present disclosure provides a method of forming a recess in a surface of a substrate, the method comprising:

providing an abrasive article comprising a structured abrasive member disposed along a peripheral surface of a support member, wherein the structured abrasive member comprises a structured abrasive layer comprising shaped abrasive composites secured to a backing, wherein the backing is proximate to the support member, and wherein the shaped abrasive composites comprise abrasive particles retained in a binder material;

frictionally contacting the structured abrasive layer with the surface of the substrate;

longitudinally advancing the structured abrasive layer relative to the surface of the substrate; and

rotating the substrate around a rotational axis perpendicular to the surface of the substrate such that the structured abrasive layer maintains contact with and abrades the surface of the substrate thereby forming the recess therein, wherein the method is carried out in the absence of added loose abrasive particles or abrasive slurry.

In another aspect, the present disclosure provides an abrasive wheel comprising a structured abrasive member disposed on a peripheral surface of a circular support wheel, wherein the structured abrasive member comprises a structured abrasive layer comprising shaped abrasive composites secured to a backing, wherein the backing is proximate to the support wheel, wherein the structured abrasive member comprises wherein the shaped abrasive composites comprise abrasive particles retained in a binder material, wherein the support wheel has an outer diameter and the structured abrasive member has a substantially uniform width, and wherein the ratio of the width of the structured abrasive member to the outer diameter of the support wheel is less than or equal to 0.125.

The abrasive wheel is useful, for example, for practicing methods according to the present disclosure.

In yet another aspect, the present disclosure provides a cover comprising:

a sheet having first and second opposed major surfaces, wherein the sheet comprises glass, ceramic, or a combination thereof;

a spherically concave recess abutting and extending inwardly from the first major surface, wherein the spherically concave recess has an innermost portion; and

a cylindrical passage which extends between and abuts the second major surface and the innermost portion of the spherically concave recess, and wherein the cylindrical passage is perpendicular to the first major surface.

What is claimed is:

1. A method of forming a recess in a surface of a substrate, the method comprising:

providing an abrasive article comprising a structured abrasive member disposed along a peripheral surface of a support member, wherein the structured abrasive member comprises a structured abrasive layer comprising shaped abrasive composites secured to a backing, wherein the backing is proximate to the support member, and wherein the shaped abrasive composites comprise abrasive particles retained in a binder material;

frictionally contacting the structured abrasive layer with the surface of the substrate;

longitudinally advancing the structured abrasive layer relative to the surface of the substrate; and

rotating the substrate around a rotational axis perpendicular to the surface of the substrate such that the structured abrasive layer maintains contact with and abrades the surface of the substrate thereby forming the recess therein, wherein the method is carried out in the absence of added loose abrasive particles or abrasive slurry.

2. The method of claim 1, wherein the abrasive article comprises an abrasive wheel or an abrasive belt.

3. The method of claim 1, wherein the abrasive particles comprise at least one of cerium oxide or diamond.

4. The method of claim 1, wherein the recess comprises a dimple.

5. The method of claim 1, wherein the recess comprises a ring.

6. The method of claim 1, wherein the substrate has a cylindrical passage extending therethrough perpendicular to the surface of the substrate, and wherein the rotational axis is collinear with the cylindrical passage.

7. The method of claim 1, wherein the recess has a continuously concave surface.

8. The method of claim 1, wherein said moving at least one of the abrasive article and the substrate relative to the other comprises rotating the substrate.

9. The method of claim 1, wherein the substrate is selected from the group consisting of a glass sheet and a sapphire sheet.

10. An abrasive wheel comprising a structured abrasive member disposed on a peripheral surface of a circular support wheel, wherein the structured abrasive member comprises a structured abrasive layer comprising shaped abrasive composites secured to a backing, wherein the backing is proximate to the support wheel, wherein the shaped abrasive composites comprise abrasive particles retained in a binder material, wherein the support wheel has an outer diameter and the structured abrasive member has a substantially uniform width, and wherein the ratio of the width of the structured abrasive member to the outer diameter of the support wheel is less than or equal to 0.125.

11. The abrasive wheel of claim 10, wherein the peripheral surface of the support wheel is substantially covered by the structured abrasive layer.