more attributes used to carry out the classification of step 206 include any one or more attributes that can be derived from a defect inspection or review tool, as noted above.

[0034] In step 208, a first classifier 117 is generated. In one embodiment, the first classifier 117 is generated, or trained, based on the first manual classification of defects of step 206 and the one or more associated attributes. In one embodiment, the one or more processors 106 of controller 104 may generate, or train, the first classifier 117 and store the first classifier 117 in memory 108. In one embodiment, the first classifier includes an ensemble learning classifier. For example, the ensemble learning classifier may include a random forest classifier. For instance, the one or more processors 106 may train a random forest classifier that operates by constructing multiple decision trees during a training period and outputting a class that is the mode of the classes of the individual trees. In this regard, the one or more processors 106 may use the manual classification of the defects and the associated attributes to train a random forest classifier. The implementation of a random forest classifier is described generally by Breiman in *Random Forests*, Machine Learning, Vol. 45, Issue 1, pp. 5-32 (2001), which is incorporated herein by reference in the entirety. Random forests are also discussed by Kulkarni et al. in *Random Forest Classifiers: A Survey and Future Research Directions*, International Journal of Advanced Computing, Vol. 36, Issue 1, pp. 1144-1153 (2013), which is incorporated herein by reference in the entirety.

[0035] By way of another example, the ensemble learning classifier includes a support vector machine (SVM). The one or more processors 106 may use the first manual classification of the defects and the associated attributes to train a SVM-based classifier. The implementation of a SVM-based classifier is described generally by Xie et al. in *Detection and Classification of Defect Patterns in Optical Inspection Using Support Vector Machines*, Intelligent Computing Theories Lecture Notes in Computer Science, Vol. 7995, pp. 376-384 (2013), which is incorporated herein by reference in the entirety.

[0036] It is noted herein that the classifier generated in step 208 may include any classifier known in the art and is not limited to an ensemble learning classifier. For

1. A method for defect classification comprising:

acquiring one or more images of a specimen, the one or more images including a plurality of defects;

grouping each of at least a portion of the plurality of defects into one of two or more groups of defect types based on one or more attributes of the defects;

receiving a signal from a user interface device indicative of a first manual classification of a selected number of defects from each of the two or more groups of defect types;

generating a classifier based on the received first manual classification and the attributes of the defects;

classifying, with the classifier, at least some of the plurality of defects;

determining, with a voting procedure, a confidence level for the at least some of the plurality of defects classified with the classifier, wherein the voting procedure includes a vote from each classification output of the classifier;

identifying a selected number of defects classified by the classifier having the lowest confidence level;

receiving a signal from the user interface device indicative of an additional manual classification of the selected number of the defects having the lowest confidence level, wherein the classifier comprises a random forest classifier, wherein each tree of the random forest classifier has a classification output that is configured as a vote in the voting procedure; and

determining whether the additional manual classification identifies one or more additional defect types not identified in the first manual classification.

2. The method of claim 1, further comprising:

responsive to the identification by the additional manual classification of one or more defect types not identified by the first manual classification, generating an additional classifier based on the first manual classification and the additional manual classification;

classifying, with the additional classifier, one or more defects not classified by the first manual classification or the additional manual classification;

identifying a selected number of defects classified by the additional classifier having the lowest-confidence level;

receiving a signal from the user interface device indicative of a second additional manual classification of the selected number of the defects having the lowest-confidence level; and

determining whether the second additional manual classification identifies one or more additional defect types not identified in the first manual classification or the additional manual classification.

3. The method of claim 1, further comprising:

responsive to the determination that the additional manual classification does not identify a defect type not included in the first manual classification, reporting at least the defect types classified by the first manual classification and the defect types classified by the classifier.

4. The method of claim 1, wherein the grouping each of at least a portion of the plurality of defects into one of two or more groups of defect types based on one or more attributes of the defects comprises:

grouping each of at least a portion of the plurality of defects into one of two or more groups of defect types with a real-time automatic defect classification (RT-ADC) scheme applied to the one or more attributes.

5. The method of claim **1**, wherein the random forest classifier comprises:

at least one of a decision tree classifier or a multiple decision tree classifier.

6. The method of claim **1**, wherein the voting procedure comprises a majority two vote scheme.

7. An apparatus for defect classification comprising:

an inspection tool, the inspection tool including one or more detectors configured to acquire one or more images of at least a portion of a specimen;

a user interface device; and

a controller, the controller including one or more processors communicatively coupled to the one or more detectors of the inspection tool, wherein the one or more processors are configured to execute a set of program instructions stored in memory, the set of program instructions configured to cause the one or more processors to:

receive the one or more images from the one or more detectors of the inspection tool;

group each of at least a portion of the plurality of defects into one of two or more groups of defect types based on one or more attributes of the defects;

receive a signal from a user interface device indicative of a first manual classification of a selected number of defects from each of the two or more groups of defect types;

generate a classifier based on the received first manual classification and the attributes of the defects;

classify, with the classifier, at least some of the plurality of defects;

determine, with a voting procedure, a confidence level for the at least some of the plurality of defects classified with the classifier, wherein the voting procedure includes a vote from each classification output of the classifier;

identify a selected number of defects classified by the classifier having the lowest-confidence level;

receive a signal from the user interface device indicative of an additional manual classification of the selected number of the defects having the lowest-confidence level, wherein the classifier comprises a random forest classifier, wherein each tree of the random forest classifier has a classification output that is configured as a vote in the voting procedure; and

determine whether the additional manual classification identifies one or more additional defect types not identified in the first manual classification.

8. The apparatus of claim **7**, wherein controller is further configured to:

responsive to the identification by the additional manual classification of one or more defect types not identified by the first manual classification, generate an additional classifier based on the first manual classification and the additional manual classification;

classify, with the additional classifier, one or more defects not classified by the first manual classification or the additional manual classification;

identify a selected number of defects classified by the additional classifier having the lowest confidence level;

receive a signal from the user interface device indicative of a second additional manual classification of the selected number of the defects having the lowest-confidence level; and

determine whether the second additional manual classification identifies one or more additional defect types not identified in the first manual classification or the additional manual classification.

9. The apparatus of claim **8**, wherein the controller is further configured to:

responsive to the determination that the additional manual classification does not identify a defect type not included in the first manual classification, report at least the defect types classified by the first manual classification and the defect types classified by the classifier.

10. The apparatus of claim **7**, wherein the controller is further configured to:

group each of at least a portion of the plurality of defects into one of two or more groups of defect types with a real-time automatic defect classification (RT-ADC) scheme applied to the one or more attributes.

11. The apparatus of claim **8**, wherein at least one of the first classifier or the additional classifier comprises:

at least one of a decision tree classifier or a multiple decision tree classifier.

12. The apparatus of claim **7**, wherein the controller is further configured to:

calculate a confidence level with a voting procedure that comprises a majority two vote scheme.

13. The apparatus of claim **7**, wherein the inspection tool comprises:

an electron beam defect review tool.

14. The apparatus of claim **7**, wherein the inspection tool comprises:

a darkfield inspection tool.

15. The apparatus of claim **7**, wherein the inspection tool comprises:

a brightfield inspection tool.

16. The apparatus of claim **7**, wherein each tree of the random forest classifier has a classification output that is configured as a vote in the voting procedure.